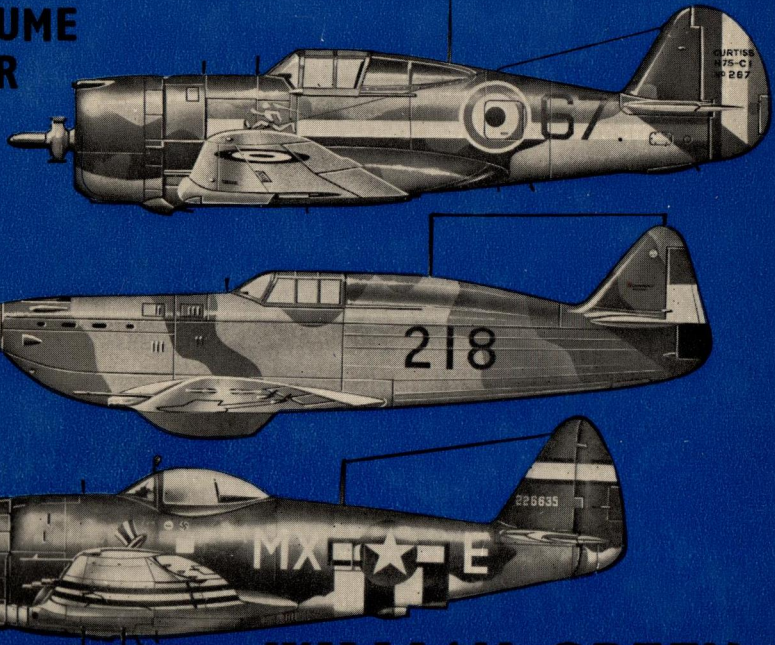
WAR PLANES OF THE SECOND WORLD WAR

FIGHTERS

VOLUME FOUR



WILLIAM GREEN

FIGHTERS VOLUME FOUR

DOUBLEDAY

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WAR PLANES OF THE SECOND WORLD WAR

by

William Green

Volume IV

F I G H T E R S

This is the fourth volume in a series of books that presents a comprehensive, illustrated history of all the aircraft of the combatant countries of World War II. The first four provide a complete picture of the development of the fighters and fighter bombers of each of the warring nations. Volume IV contains specifically those aircraft used by the United States and Yugoslavia.

In addition to describing those planes which actually saw combat with their respective air arms, Mr. Green has recorded full details of those that, for one reason or another, never attained service. Many of the aircraft found herein have never before been illustrated or described in detail. William Green's authoritative text is supplemented by three-view line drawings by Dennis I. Punnett.

WAR PLANES FIGHTERS 4 DOUBLEDAY

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VOLUME FOUR

WILLIAM GREEN

With Drawings by Dennis I. Punnett

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INTRODUCTION

One of the most remarkable aspects of wartime aircraft production was the rapidity with which the U.S. aviation industry achieved a phenomenal output of fighters. When the United States entered World War II the fighter squadrons of both the U.S.A.A.F. and the U.S. Navy were operating warplanes which were admittedly inferior to the fighters employed by most other combatants. To a major extent the inferiority of U.S.A.A.F. fighters was the result of the "ascendancy of bombardment over pursuit" belief which was widespread in official American circles in the years immediately preceding World War II. The P-39 Airacobra and the P-40 Warhawk were products of this school of thought; warplanes which were to be described officially as "disappointing" and which invariably possessed an inferior performance to the fighters by which they were opposed. It is sobering to recall that these aircraft constituted more than fifty per cent of all U.S.A.A.F. fighters committed overseas until September 1943.

Fortunately for the U.S.A. and her allies, however, the U.S. aircraft industry was quick to learn, and superior fighters were soon rolling off the assembly lines in astonishing quantities, these providing the bulk of more than 101,500 fighters of nine principal types produced prior to V-J Day, by American aircraft manufacturers for the U.S. forces and, as the war progressed, all the U.S.A.'s allies. The P-51 Mustang in its Merlin-powered forms was probably the best piston-engined fighter produced in quantity by any of the combatants, while the F6F Hellcat, if eclipsed in certain performance respects by the F4U Corsair, is generally considered to have been the best all-round shipboard fighter. The U.S. aircraft industry was singularly prolific in the number and variety of experimental fighter designs built and tested during the war years, and thus a large part of this, the fourth fighter volume of *War Planes of the Second World War*, is devoted to the numerous American experimental fighter designs or experimental variants of production types which, for one reason or another, failed to attain operational service. These range in weight from the tiny wooden 3,670-lb. Bell XP-77, intended to conserve strategic materials, to the immense 39,000-lb. Lockheed XP-58, which at one period of its career was intended to break up bomber formations by bombarding them with 75-mm. shells. In design they vary from the completely orthodox to the radical tail-first XP-55 Ascender, the tailless XP-56 built entirely of magnesium, and the twin-boom XP-54 with built-in elevator for the pilot and hinged nose armament.

Apart from the U.S. aircraft industry one other aircraft industry finds a place in this volume: that of Yugoslavia. Although this industry's fighter progeny participated but briefly in the conflict, they are indicative of the high standard of indigenous design attained by Yugoslav aircraft manufacturers at the time of the German onslaught.

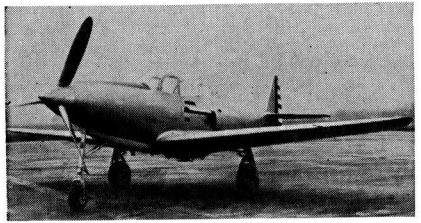
In conclusion, I should like to record my sincere thanks to my good friends Warren M. Bodie, Harold G. Martin, H. Andrews, and Peter M. Bowers, who have supplied some of the photographs that appear on the pages that follow, and to Dustin W. Carter, Ray Wagner, author of that invaluable work of reference, *American Combat Planes*, Mauno A. Salo, and Zoran Jerin, all of whom have furnished information which is included in this volume.

October 1961 William Green

BELL P-39 AIRACOBRA

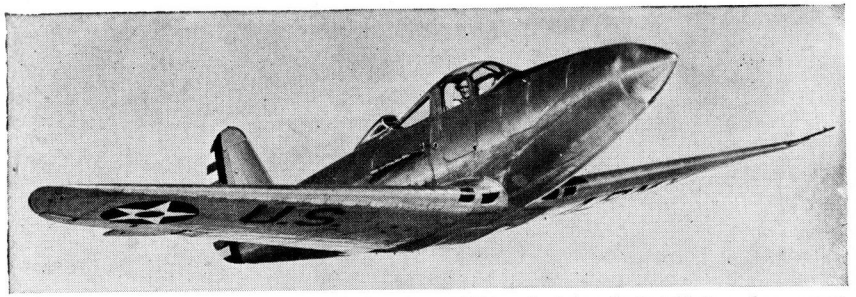
U.S.A.

When, in June 1936, the Bell Aircraft Corporation's design team, headed by Robert J. Woods and Harland M. Poyer, began the design of a single-seat fighter, they adopted the radical idea of mounting the engine behind the pilot, driving the airscrew by means of a 10-ft. extension shaft. Such an arrangement was not unique, having been featured two years earlier by the experimental Westland F.7/30 biplane and being at that time under test in the Koolhoven F.K.55 monoplane, but to the Bell team it appeared to offer superior manoeuvrability, the engine weight being concentrated around the fighter's c.g.; it facilitated the installation of a heavy nose armament; it offered good visibility for the pilot, and it permitted the use of a nosewheel undercarriage. Events were to prove that this unorthodoxy was not entirely justified, and in the official history of the U.S.A.A.F., the Bell fighter was to be described as "specially disappointing . . ." possessing "... a low ceiling, slow rate of climb, and relative lack of manoeuvrability [which] put its pilots at a decided disadvantage wherever they fought."



The P-39 Airacobra was a poor interceptor and "practically useless over 17,000 feet", but in another role—that of low-level close support—it excelled. It proved capable of absorbing an amazing amount of battle damage and it

(Left) The XP-39 (38-326), the first prototype Airacobra, and (below) a service test YP-39.

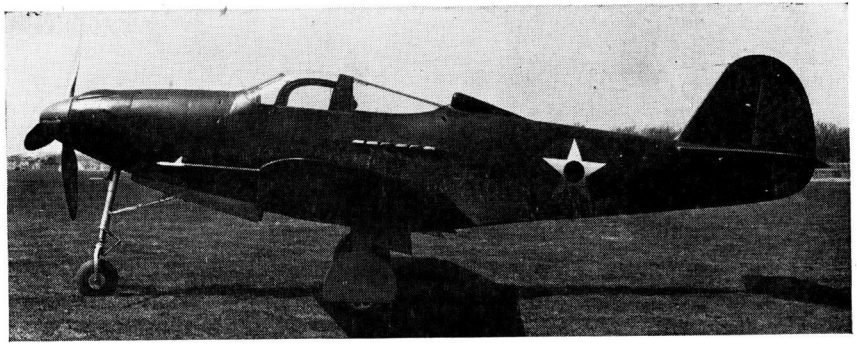


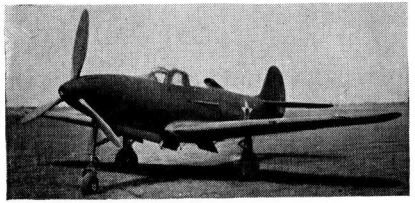
The original Airacobra prototype modified as the XP-39B and prior to the installation of armament. The changes were incorporated in the YP-39 Airacobras.

gained a justifiable reputation as a pilot's aeroplane. That it was not a good interceptor was hardly the fault of the design team for it was born too early, at a time when the "ascendancy of bombardment over pursuit" was the current belief in U.S. military circles; when coastal defence and ground attack were considered to be the primary roles of the fighter and priority was given to low-altitude qualities.

Bell's proposals were submitted to the Army Air Corps in a specification dated May 18, 1937, and a prototype was ordered as the XP-39 on October 7th. The XP-39 was powered by a 1,150 h.p. Allison V-1710-17 engine which was fitted with a B-5 turbo-supercharger on the port side of the centre fuselage. Provision was made for the installation of two 0.5-in. guns in the forward fuselage and a single 25-mm. cannon firing through the airscrew shaft. In December 1938, some five months before flight trials commenced, it was decided to replace the 25-mm. gun with a 37-mm. Oldsmobile T-9 cannon, although no armament was actually installed in the first prototype. The XP-39 flew for the first time in April 1939, and on the 27th of that month Bell received a contract for a service test quantity of twelve YP-39s and one YP-39A. During initial trials, the XP-39 attained the phenomenal maximum speed of 390 m.p.h. at 20,000 ft., reaching that altitude in five minutes, although normal gross weight was only 5,550 lb.

Proposals made by the NACA resulting from a study of the prototype led to the return of the XP-39 to Bell for several modifications. These resulted in considerable changes to the external appearance of the aircraft. The radiators were removed from the fuselage sides and installed in the leading edges of modified wing roots, the turbo-supercharger was removed and a V-1710-39 engine rated at 1,090 h.p. at 13,300 ft. installed, the carburettor air intake was mounted aft of the cockpit, a shallower cockpit enclosure was adopted, and changes were made to the wheel doors. Later, redesigned, broader vertical tail surfaces were fitted and armament was installed. Re-





(*Above*) *One of twenty P-39C Airacobras.* (*Left*) *The P-39D-1 and* (*below, left*) *the P-39D-2.*

designated XP-39B, the prototype resumed flight trials on November 25, 1939. Empty weight had grown from 3,995 lb. to 4,530 lb., and normal gross weight was 5,834 lb. Performance had suffered from the modifications, maximum speed being reduced to 375 m.p.h. at 15,000 ft. and climb to 20,000 ft. taking 7.5 minutes. Manoeuvrability showed a considerable improvement, however, as a result of a reduction in wing span from 35 ft. 10 in. to 34 ft., and an increase in overall length from 28 ft. 8 in. to 29 ft. 9 in., and it was decided to embody the changes made in the XP-39B in the service test machines.

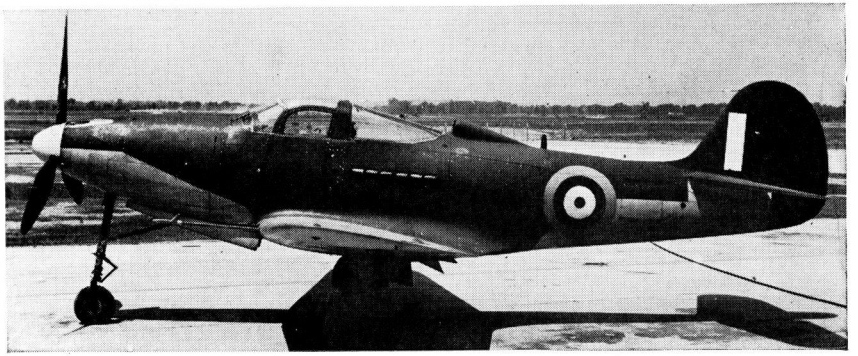
The first YP-39 was flown in September 1940 with the V-1710-37 engine, and full armament was fitted, comprising the 37-mm. cannon with 15 rounds, a pair of 0.5-in. guns with 200 r.p.g., and two 0.3-in. guns with 500 r.p.g. Some armour protection was provided for the pilot, and empty and normal loaded weights rose to

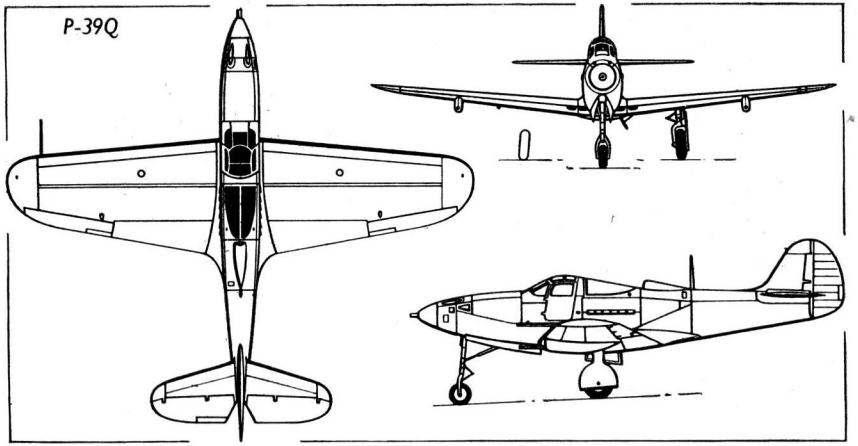
5,042 lb. and 7,000 lb. respectively. The YP-39A was to have been delivered with the high-altitude V-1710-31 engine delivering 1,150 h.p., but this plan was cancelled, the aircraft being delivered as a standard YP-39.

Since the initial production version was to be virtually identical to the YP-39 apart from the installation of the slightly more powerful V-1710-35 engine rated at 1,150 h.p. at 12,000 ft., it is rather surprising that when an initial order for eighty machines was placed on August 10, 1939, the aircraft were allocated the designation P-45, although this was changed to P-39C prior to the delivery of the first production aircraft. On September 14, 1940, the initial contract was modified, self-sealing fuel tanks and wing guns being specified for the twenty-first and subsequent machines which became the first P-39Ds, or Bell Model 15s, and an additional 344 Airacobras of this type had been ordered on the previous day. Whereas the P-39C, or Model 13, was virtually identical to the YP-39, the P-39D had four wing-mounted 0.3-in. guns with 1,000 r.p.g., two fuselage-mounted 0.5-in. guns with 200 r.p.g., and one 37-mm. cannon with thirty rounds. The introduction of self-sealing tanks reduced internal fuel capacity from 141.5 Imp. gal. to 100 Imp. gal. This could be supplemented by a 62.4 Imp. gal. drop tank, and the bullet-proof windscreen panels and armour added 245 lb. to the weight of the aircraft, with the result that climb and altitude performance suffered.

The first P-39D Airacobras entered service with the Army Air Corps in February 1941, and their development had coincided with a special export version, the Model 14, originally intended for the Armée de l'Air and ordered by the British government on April 13, 1940. No less than 675 Bell Model 14 fighters were ordered for the R.A.F., by which service it was

The Model 14 *Airacobra I was tested by the R.A.F. but rejected as unsuitable. One operational sortie was undertaken by the R.A.F.'s No.* 601 *Squadron with this type.*



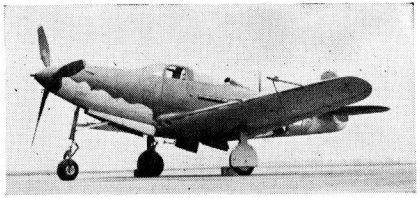


initially named Caribou, although the original American name of Airacobra had been adopted by July 3, 1941 when the first machine reached the United Kingdom. Powered by the 1,150 h.p. Allison V-1710-E4 (-35) engine, the Model 14 was essentially similar to the P-39D apart from the replacement of the 37-mm. cannon by a 20-mm. Hispano M1 cannon with sixty rounds, and the installation of six 0.303-in. Browning guns.

The first Model 14, or Airacobra I, was test flown in the U.K. on July 6, 1941, and by the end of September, eleven machines had been received by No. 601 Squadron. During trials by the Air Fighting Development Unit at Duxford performance proved disappointing. The aircraft had received so much publicity that the results of speed tests were difficult to believe, maximum speed being 33 m.p.h. lower than anticipated, the manufacturers eventually admitting that their performance figures were obtained with a highly polished machine weighing a ton less than the R.A.F.'s Airacobra I. Although pleasant to fly, the Bell fighter proved to be definitely inferior to the Hurricane and Spitfire in climb rate and ceiling, and the 750-yard take-off run of the Airacobra excluded its operation from some smaller fighter fields. Armament accessibility was extremely poor, and there was a lethal density of carbon monoxide in the cockpit after the nose machine guns had been fired. A considerable number of defects and faulty installations discovered when the aircraft arrived in the U.K. delayed assembly, but on October 9, 1941, permission was given to No.

601 Squadron to take the first four modified Airacobras on trial operations from Manston. A strafing operation was undertaken over the French coast and some invasion barges were attacked before the aircraft returned to their home base on October 11th. Lack of spares and the need for further modifications contributed to an extremely high unserviceability rate, and no further operations were undertaken, the aircraft being withdrawn from R.A.F. service in December.

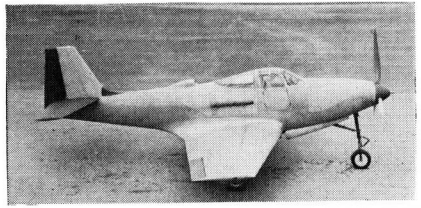
Of the 675 Model 14 fighters scheduled to go to the R.A.F., 212 were diverted to the Soviet Union, fifty-four were lost at sea, and 179 were taken over as P-400s by the A.A.F. in December 1941 for emergency use in the South Pacific. More than a hundred P-400s, together with ninety P-39Ds, were despatched to Australia to reinforce A.A.F. units in the Pacific between December 23, 1941 and March 18, 1942, one of the first operational formations in the area to receive them being the 67th Fighter Squadron. The P-400s and P-39Ds of the 35th Fighter Group's 40th and 41st Fighter Squadrons based at Port Moresby, New Guinea, had the task of intercepting Japanese attacks, but the official A.A.F. history was later to say: "The Airacobra, even in a good state of repair, was unable to meet the Japanese fighters on equal terms." With the formation of the U.S. 12th Air Force in the Middle East in the autumn of 1942, Airacobras saw service in the Mediterranean area with the 81st and 350th Fighter Groups and two squadrons of the 68th Observation Group. Their aircraft were diverted from a Soviet consignment, being P-400s and P-39D-1s. The latter designation was applied to the first 336 aircraft of an order for 494 Model 14As placed in June 1941 with Lend-Lease funds. These had a 20-mm. M1 cannon in place of the standard 37-mm. weapon, and were the first Airacobras to be fitted with the small dorsal



A P-39K-1 Airacobra, 210 examples of which were built for the Army Air Force.

fin fillet which was subsequently to be standardised. The remaining 158 machines on this order were completed as P-39D-2s which differed only in having uprated V-1710-63 (E6) engines developing 1,325 h.p. for take-off and having a 2:1 reduction gear. Some of these, as with other D-model Airacobras, were converted to P-39D-3 and D-4 ground attack aircraft with armoured oil and glycol coolers and two cameras in the rear fuselage. In late 1942 some P-39s en route from the U.K. to Tunisia to reinforce the 91st and 92nd Squadrons of the 81st Fighter Group force-landed in Portugal, were interned and were later taken on strength by the Portuguese Air Force. In the Middle East the Airacobras were used primarily for very low-altitude strafing missions, escorted by Warhawks or Spitfires.

Three P-39Ds were modified to flight test the experimental Continental V-1430-1 under the designation XP-39E, the first two machines being ordered on April 10, 1941, with the third being added later. In the event, the Continental engine had reached an insufficiently advanced stage of development when the XP-39E airframes were completed, and the 1,325 h.p. V-1710-47 engine was therefore installed. The XP-39E featured laminar-flow wings with



square-cut tips, and each of the three aircraft tested different vertical tail surfaces, the first being conical, the second being cut-off square and rather short, and the third bearing a resemblance to that of the P-51. Other modifications included the re-location of the carburettor air intake and enlarged wing root radiator intakes. The wing span and gross area of the XP-39E were increased to 35 ft. 10 in. and 236 sq. ft., and empty and loaded weights were 6,936 lb. and 8,918 lb. respectively. During trials, a maximum speed of 386 m.p.h. was attained at 21,680 ft.

As the "dash number" system for distinguishing minor modifications to A.A.F. aircraft had not been fully developed during the early stages of the Airacobra's career, its designation suffix letters ran far into the alphabet without

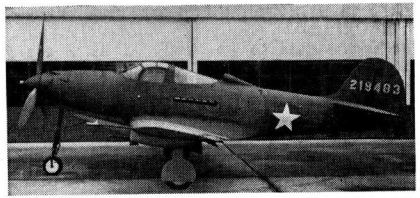
(Above, left) A P-49L (42-4563); (left) one of three XP-39Es and (below) a P-39F-1 Airacobra.

being accompanied, for some time, by any really major changes. Thus, the 229 P-39Fs delivered were identical to the P-39D apart from having twelve exhaust stubs on each side of the centre fuselage instead of the usual six, and an Aeroproducts airscrew instead of the Curtiss Electric type. Field modifications (additional belly armour and rear-fuselage cameras) to suit the aircraft for ground support duties resulted in the P-39F-2. The P-39G, 1,800 examples of which were ordered on August 21, 1941, underwent several modifications during the contract stage leading to different suffix letters being applied as production progressed, none in fact bearing the "G" suffix letter, and the last twenty-five P-39Fs were fitted with the 1,100 h.p. V-1710-59, thus becoming P-39Js, the suffix letters "H" and "I" not being assigned.

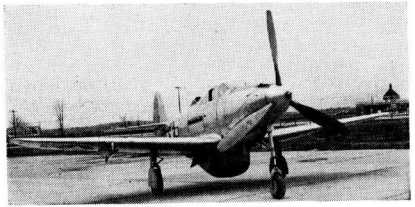
As the first of the redesignated P-39Gs, the P-39K-1-BE differed in no material respect from the P-39D-2, apart from its 1,325 h.p. V-1710-63 engine driving an Aeroproducts airscrew. Normal and maximum weights were increased to 7,600 lb. and 8,400 lb., but apart from a slight reduction in range, performance remained similar to that of the P-39D. Two hundred and ten P-39K Airacobras were built concurrently with 250 P-39Ls which reverted to the Curtiss Electric airscrew, there being no discernible difference between this model and the P-39D-2, apart from a modified nose-wheel of low-drag design. The third redesignated form of G-model was the P-39M which began to appear in November 1942. The 240 P-39M Airacobras were fitted with a V-1710-83 (E18) engine in an attempt to improve high-altitude performance, this power plant developing 1,200 h.p. for take-off and 1,125 h.p. at 15,500 ft. This added only 10 m.p.h. at rated altitude which was still far too low for aerial combat, and the Airacobra remained primarily a ground-attack aircraft.

Up to this time, the Airacobra had been manufactured in relatively small numbers, and the first model to be produced on a really large-scale was the P-39N. In all, 2,095 examples of this version were constructed, all powered by the V-1710-85 (E19) engine with a similar rating to that of the M-model's -83 but with a different airscrew reduction gear ratio and an Aeroproducts airscrew in place of the Curtiss Electric. At the request of the A.A.F., after the completion of 166 P-39N-0-BE Airacobras, four fuel cells were removed to reduce the internal fuel capacity from 100 to 72.4 Imp. gal., and so reduce the maximum permissible gross weight from 9,100 lb. to 8,750 lb. Some five hundred P-39N-0s were followed by 900 P-39N-1s with minor internal changes, and 695 P-39N-5s in which the total weight of armour was reduced from 231 to 193 lb., a curved armour head plate supplanting the bullet-proof glass behind the pilot.

The letter "O" not being used as a suffix owing to the possibility of it being confused with the similar numeral, and "P" not being assigned, the next version of the Airacobra became the P-39Q, and this was to be built in larger numbers than any other model. The principal change in the P-39Q was concerned with the fighter's armament. The four 0.3-in. wing guns were removed and a single 0.5-in. gun was mounted beneath each mainplane. There was no further engine change in the Airacobra after the appearance of the N-model, but there were some differences in internal fuel tankage among the early P-39Qs, the P-39Q-1-BE having 72.4 Imp. gal., the -5-BE having 91.6 gal., and the -10-BE and subsequent models reverting to the original 100 gal. Weight of armour varied among different production blocks; the -1-BE having 231.4 lb., the -5-BE having 193.4 lb., and the -10-BE having 227.1 lb. In the P-39Q-20-BE batch the underwing guns were sometimes omitted,



(*Above*) *P-39Q-1-BE and* (*below*) *a P-39Q-5-BE.*



(*Below*) *A U.S. Navy XTDL-1* (*ex-P-39Q-10-BE*).

and various types of airscrew were fitted, the P-39Q-21 and -25-BE having four-bladers, although the P-39Q-30-BE reverted to the three-blader as tests indicated that directional stability was materially worsened by the four-blader without any commensurate gain in performance.

One of the last A.A.F. units to receive the Airacobra was the 332nd Fighter Group which took seventy-five P-39Qs to the 15th Air Force in Italy in February 1944. No less than 4,905 P-39Qs had been completed when Airacobra production finally terminated in August 1944, the bulk of which were supplied to the Soviet Union. In fact, of the 9,558 Airacobras of all types produced during the production life of this fighter, 4,924 were allocated to the Soviet Union, 4,758 of these reaching their destination. The Airacobra was popular with the Russians who appreciated its close-support capabilities. One hundred and sixty-five Airacobras were also supplied to the Free French, and the peak A.A.F. inventory of this fighter was 2,105 machines in February 1944, although by the following August all first-line groups had re-equipped with later types.

The following specification relates to the P-39D, figures in parentheses referring to the P-39Q-5-BE.

Type: *Single-seat Fighter-bomber.* **Power Plant:** *One* 1,150 (1,325) *h.p. Allison V-*1710-35 (-85) *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *One* 37-*mm. M4 cannon with* 30 *rounds, four* 0.3-in. *machine guns with* 1,000 *r.p.g., and two* 0.5-*in. guns with* 200 *r.p.g.* (*one* 37-*mm. cannon with* 30 *rounds, two* 0.5-*in. guns with* 200 *r.p.g., and two* 0.5-*in. guns with* 300 *r.p.g.*) *plus one* 250-*lb.*, 325-*lb., or* 500-*lb. bomb.* **Performance:** *Maximum speed,* 335 (330) *m.p.h. at* 5,000 *ft.*, 355 (357) *m.p.h. at* 10,000 *ft.*, 360 (376) *m.p.h. at* 15,000 *ft.; climb to* 5,000 *ft.*, 1.9 (2.0) *min., to* 10,000 *ft.*, 3.9 (4.0) *min., to* 20,000 *ft.*, 9.1 (8.5) *min.; maximum range* (*clean*), 600 (525) *mls. at* 10,000 *ft. at* 231 (250) *m.p.h.*, (*with one* 145.7 *Imp. gal. drop tank*), 1,100 (1,075) *mls. at* 196 (195) *m.p.h.; service ceiling,* 32,100 (35,000) *ft.* **Weights:** *Empty,* 5,462 (5,645) *lb., normal loaded,* 7,650 (7,600) *lb.; maximum,* 8,200 (8,300) *lb.* **Dimensions:** *Span,* 34 *ft.* 0 *in.; length,* 30 *ft.* 2 *in.; height,* 11 *ft.* 10 *in.* (12 *ft.* 5 *in.*); *wing area,* 213 *sq. ft.*

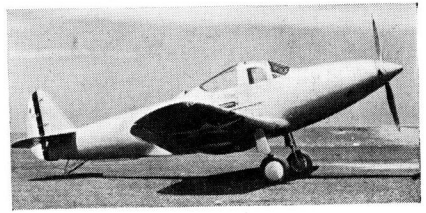
BELL XFL-1 AIRABONITA

U.S.A.

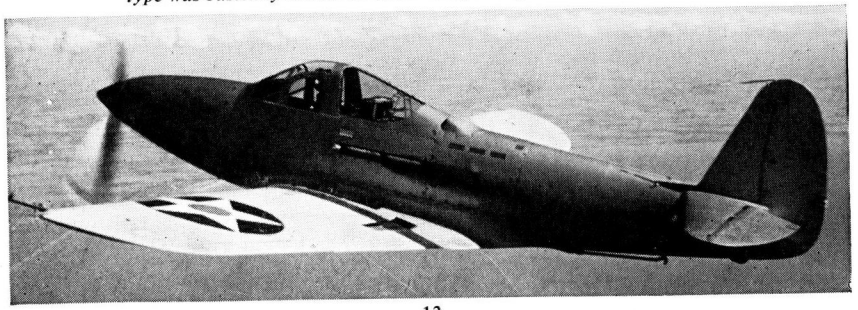
The XFL-1 Airabonita was an experimental shipboard fighter basically similar to and developed in parallel with the land-based XP-39 Airacobra. A U.S. Navy contract for one prototype of the XFL-1 was placed on November 8, 1938, and this aircraft (BuAer No. 1588) was flown for the first time on May 13, 1940. The XFL-1 was powered by an Allison XV-1710-6 engine installed aft of the pilot and driving a 10 ft. 4½ in. diameter Curtiss three-blade airscrew by means of an extension shaft, and differed from its land-based counterpart principally in having underwing radiators and a tailwheel undercarriage. The main undercarriage members were transferred to the front spar, an arrester hook was fitted, the vertical tail surfaces were redesigned, and the airframe was re-stressed for carrier operation.

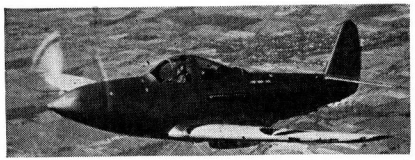
The XFL-1 had provision for two 0.3-in. machine guns in the fuselage nose and a 0.5-in. machine gun or a 37-mm. cannon firing through the airscrew hub, although no armament was in fact installed. Some difficulties with the Allison engine delayed delivery of the prototype to the U.S. Navy until February 1941, and, subsequently, the XFL-1 failed its carrier qualification trials owing to undercarriage trouble. The prototype was returned to

The XFL-1 featured a tailwheel undercarriage.



The XFL-1 Airabonita (*BuAer No.* 1588) *photographed on July* 16, 1940, *during initial trials. This type was basically similar to and developed in parallel with the XP-39.*

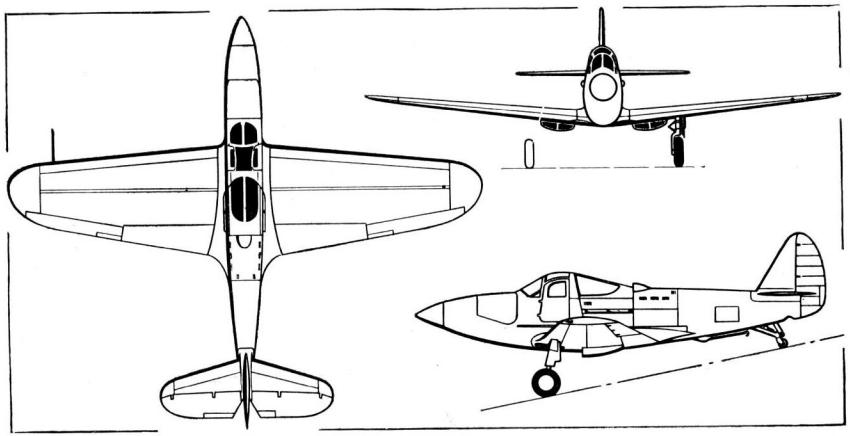




The XFL-1 differed from the XP-39 primarily in having a tailwheel-type undercarriage. Troubles with this undercarriage resulted in the failure of carrier trials.

the manufacturers in December 1941 for modifications but, shortly afterwards, it was decided that the XFL-1 was unsuitable for further development and the aircraft was discarded.

Type: *Single-seat Shipboard Interceptor and Fighter-bomber.* **Power Plant:** *One* 1,150 *h.p. Allison XV*-1710-6 *twelve-cylinder Vee liquid-cooled engine.* **Armament:** (*Proposed*) *Two* 0.3-*in. machine guns and one* 0.5-*in. machine gun or* 37-*mm. cannon.* **Performance:** *Maximum speed,* 307 *m.p.h. at sea level,* 336 *m.p.h. at* 10,000 *ft.,* 322 *m.p.h. at* 20,000 *ft.; econ. cruising speed,* 160 *m.p.h.; maximum range,* 1,072 *mls.; endurance* (60% *power*), 4.9 *hrs.,* (90% *power*), 2 *hrs.,* (*maximum power*) 1.2 *hrs.; initial climb rate,* 2,630 *ft./min.; time to* 10,000 *ft.,* 3.75 *min., to* 20,000 *ft.,* 9.2 *min.; service ceiling,* 30,900 *ft.* **Weights:** *Empty,* 5,161 *lb.; loaded,* 6,651 *lb.; maximum,* 7,212 *lb.* **Dimensions:** *Span,* 35 *ft.* 0 *in.; length,* 29 *ft.* 9⅛ *ins.; height,* 12 *ft.* 9⅜ *in.; wing area,* 232 *sq. ft.*



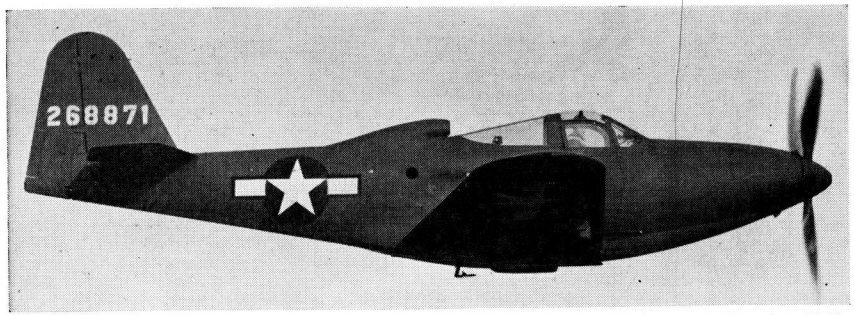
BELL P-63 KINGCOBRA

Although displaying a close external resemblance to its production predecessor, the P-39 Airacobra, the Kingcobra was in fact an entirely new design, work on which was commenced in February 1941. The Kingcobra was the only new U.S. single-seat land-based fighter flown in the two years following America's entry into World War II to attain mass production, yet it was destined never to see operational service with the U.S.A.A.F. Although the Kingcobra met the requirements to which it had been designed, these requirements were already outdated at the time they were framed, and thus no less than 2,421 Kingcobras of the total of 3,303 machines of this type built were supplied to the Soviet Union under Lend-Lease. Of the remainder, 300 were supplied to France and 332 were completed as armoured target aircraft.

A contract for two XP-63 Kingcobra prototypes was placed on June 27, 1941, and in September of the following year, before either of the prototypes had flown, quantity production was ordered. Engineering studies conducted on the three experimental XP-39E Airacobras contributed much to the development of the XP-63 which first flew on December 7, 1942 on the 1,325 h.p. Allison V-1710-47 engine. The similarly powered second prototype was flown on February 5, 1943, by which time the first prototype had already been lost while under test. The second XP-63 suffered a similar fate in May, a few days after the first flight of the modified third prototype, the XP-63A, on April 26, 1943. Essentially a production prototype, the XP-63A was powered by a V-1710-93 engine with a war emergency rating of 1,500 h.p. at sea level. This prototype was one of the fastest Kingcobras built, attaining 421 m.p.h. at 24,100 ft.

Production deliveries of the P-63A-1 began in October 1943, and by December 1944 no fewer than 1,725 P-63As had been produced, the bulk of which were immediately ferried to the Soviet Union. The Russian pilots used the Kingcobra primarily for close-support and ground strafing, making full use of the fighter's relatively good low-altitude performance and surprising ability to absorb battle damage and remain in the air. Various modifications were introduced in individual production batches. For example, the P-63A-6 was fitted with outboard wing racks for a pair of 62.4 Imp. gal. drop tanks or 500-lb. bombs, a third drop tank or bomb being carried beneath the fuselage; the P-63A-7 was fitted with an Aeroproducts airscrew of slightly reduced diameter, while the P-63A-9 introduced a 37-mm. M10 cannon in place of the earlier M4 of similar calibre, and an increase in ammunition capacity from thirty to fifty-eight 37-mm. rounds. Weight of armour protection was progressively increased from 88 lb. on the XP-63A to 266 lb. on the P-63A-10.

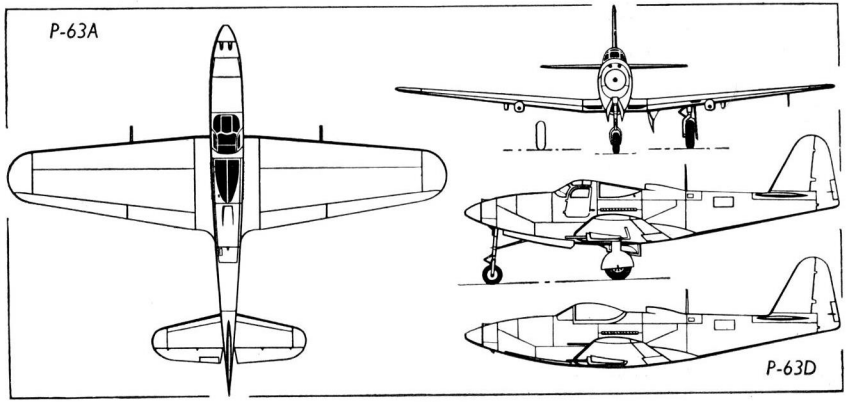
A proposal to install the 1,400 h.p. Packard-built V-1650-5 Merlin engine in the P-63B Kingcobra was abandoned, and the next version of the basic design to be built in quantity was the P-63C powered by the V-1710-117 engine with a war emergency rating of 1,500 h.p. at sea level and 1,800 h.p. with water injection. Apart from the power plant, the P-63C was essentially similar to the P-63A-10, and 1,227 examples were built, most of these being for the Soviet Union, although 300 P-63C-5s were supplied to the Armée de l'Air. The P-63C-5 introduced a ventral fin, and total weight of armour rose to 201 lb. Two hundred examples of the C-model were converted on the production line as armoured target aircraft, these being designated



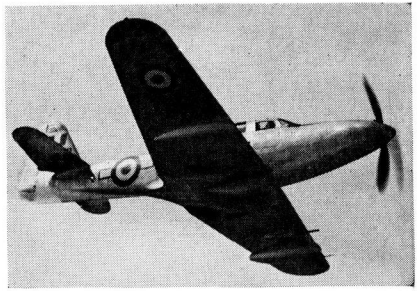
The eleventh production P-63A-1-BE Kingcobra (42-68871). *Deliveries began in October* 1943.

RP-63C-2 Kingcobras. Like the 100 RP-63As that preceded them, the RP-63Cs had all combat equipment removed and a 1,488-lb. armour skin against which frangible bullets fired by gunnery students shattered.

Progressive development of the basic King-

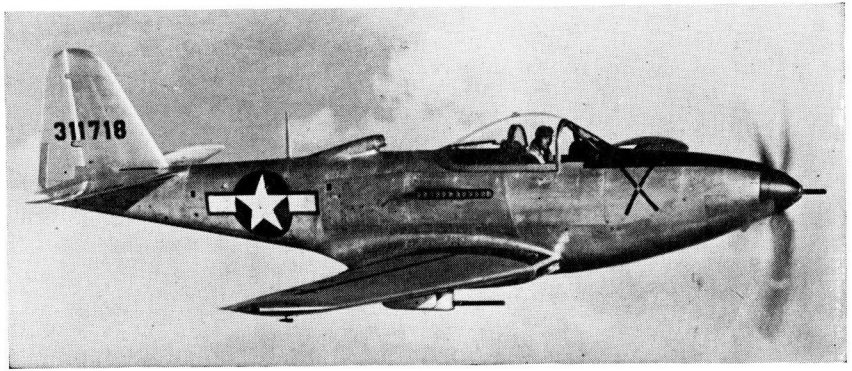


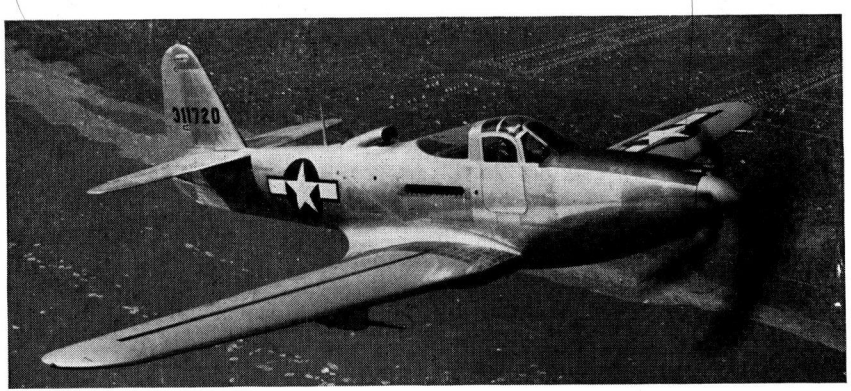
cobra design continued throughout 1944, despite the fact that the U.S.A.A.F. was no longer interested in the aircraft, and the next model to appear was the P-63D, the sole example of which flew early in 1945. The P-63D featured a V-1710-109 engine rated at 1,425 h.p. for take-off and a 10-in. increase in wing span to 39 ft. 2 in., gross area being increased from 248 sq. ft. to 255 sq. ft. A sliding "bubble" canopy was fitted, and performance included a maximum speed of 437 m.p.h. at 30,000 ft., a service ceiling of 39,000 ft., and the ability to climb to 28,000 ft. in 11.2 min. The P-63E was generally similar to the D-model but reverted to the standard cockpit. The enlarged wing and V-1710-109 engine were retained, and 2,943 were ordered for supply to allied countries under Lend-Lease. In the event, only thirteen examples were completed, the remainder being cancelled. The P-63E had increased fuel capacity, normal and maximum loaded weights of 9,400 lb. and 11,200 lb. respectively, and a maximum speed of 410



A P-63C-5 Kingcobra of the Armée de l'Air.

The sole P-63D Kingcobra (43-11718) *with sliding "bubble" canopy and enlarged wing.*

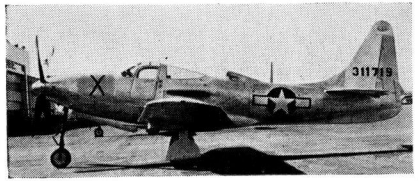




(Above) One of thirteen P-63E Kingcobras and (below, left) the sole example of the P-63F-1-BE which featured re-designed vertical tail surfaces. A total of 2,943 P-63E Kingcobras was ordered under Lend-Lease but most were cancelled shortly after V-E Day.

m.p.h. at 25,000 ft. The final wartime model was the P-63F with entirely redesigned, taller vertical tail surfaces and a 1,425 h.p. V-1710-135 engine, one example being tested.

The following specification relates to the P-63A-10, figures in parentheses relating to the P-63C-5.



Type: *Single-seat Interceptor and Fighter-bomber.* **Power Plant:** *One* 1,325 *h.p. Allison V-1710-93 (-117) twelve-cylinder Vee liquid-cooled engine.* **Armament:** *One* 37-*mm. cannon and four* 0.5-*in. machine guns plus three* 500-*lb. bombs.* **Performance:** *Maximum speed,* 361 *m.p.h. at* 5,000 *ft.,* 392 *m.p.h. at* 15,000 *ft.,* 410 *m.p.h. at* 25,000 *ft.; maximum cruising speed,* 378 *m.p.h.; range* (83.2 *Imp. gal.*), 390 *mls. at* 378 *m.p.h., (with* 500-*lb. bomb*), 450 (320) *mls.; ferry range,* 2,575 (2,100) *mls.; climb to* 25,000 *ft.,* 7.3 (8.6) *min.; service ceiling,* 43,000 (38,600) *ft.* **Weights:** *Empty,* 6,375 (6,800) *lb.; loaded,* 8,800 *lb.; maximum,* 10,500 (10,700) *lb.* **Dimensions:** *Span,* 38 *ft.* 4 *in.; length,* 32 *ft.* 8 *in.; height,* 12 *ft.* 7 *in.; wing area,* 248 *sq. ft.*

BELL P-59 AIRACOMET

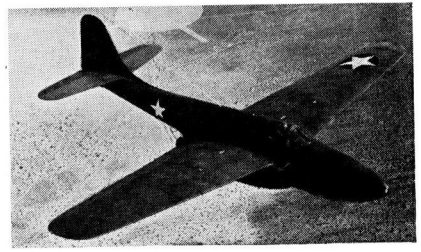
U.S.A.

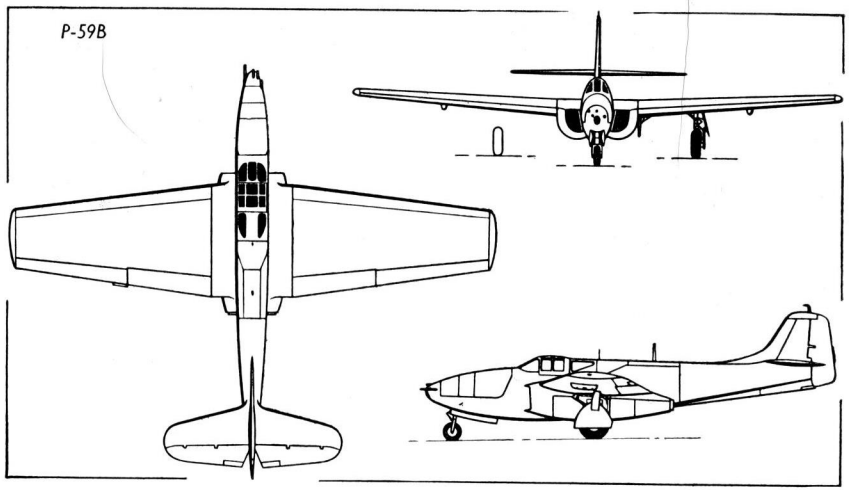
The Bell Model 27, or XP-59A Airacomet, was the first turbojet-driven aircraft to be built in the U.S.A., and the first Allied fighter to fly designed from the outset for gas turbines. The contract for the design and construction of the XP-59A was awarded to the Bell company by reason primarily of the location of the concern's plant in close proximity to the General Electric factory engaged in the construction of turbojets based on British Whittle patents. The designation "XP-59A" for the new jet fighter was selected for security reasons, the XP-59 being a defunct Bell design for a twin-boom pusher fighter powered by an R-2800-23 radial air-cooled engine driving contra-props. A contract for three XP-59A prototypes was awarded on September 5, 1941, and construction was undertaken in the strictest possible secrecy.

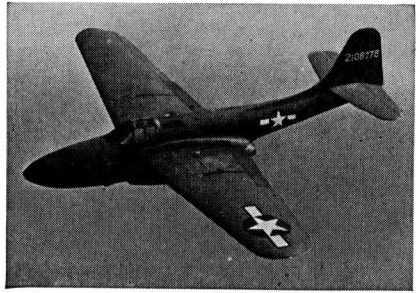
The three XP-59A Airacomet prototypes were each powered by a pair of 1,400 lb.s.t. General Electric 1-A turbojets mounted beneath the wing close to the fuselage sides, and the first aircraft was completed in a remarkably short time, flying for the first time on October 2, 1942 at Muroc Dry Lake, California. The XP-59A weighed 7,320 lb. empty and 12,562 lb. in maximum loaded condition, and carried an armament of two 37-mm. cannon with 44 r.p.g. in the fuselage nose. The maximum speed of 404 m.p.h. attained at 25,000 ft. was somewhat below expectations, the engine installation was found to result in an inordinate amount of aerodynamic interference, and the aircraft was subject to "snaking", resulting in a poor gun platform. However, thirteen service test YP-59As had been ordered in March 1942, and these were fitted with an improved version of the General Electric engine, the I-16 (later redesignated J31) rated at 1,650 lb.s.t. The first YP-59A was flown in August 1943, and this showed little improvement in performance over the prototypes. Empty weight was increased by 306 lb., and the maximum speed of 409 m.p.h. was attained at 35,000 ft. Cruising speed was 314 m.p.h. and service ceiling was 43,200 ft. The last four YP-59As differed from earlier machines in adopting the trio of 0.5-in. machine guns and single 37-mm. cannon standardised for the production P-59A. One YP-59A was delivered to the U.K. in exchange for the first production Gloster Meteor I, and two were supplied to the U.S. Navy under the designation XF2L-1, all YP-59As having been accepted by the end of June 1944.

A production order for 100 P-59A Airacomets had been placed shortly before the first prototype's initial flight, but in view of the disappointing performance of the fighter, this production order was halved on October 30, 1943, by which time the Airacomet was no longer considered as a potential operational type. Bell had already commenced preliminary design studies for a new jet fighter

One of the three XP-59A Airacomets, the first turbojet-driven aircraft to be built in the U.S.A.







(*Left*) *The eighth YP-59A Airacomet* (42-108778).

powered by a single General Electric I-16 turbojet installed in the fuselage and fed via wingroot intakes, this being designated XP-59B, but owing to the company's extensive commitments in other directions, the project had been turned over to Lockheed and redesignated XP-80, and the Airacomet was now envisaged as a potential trainer for this type.

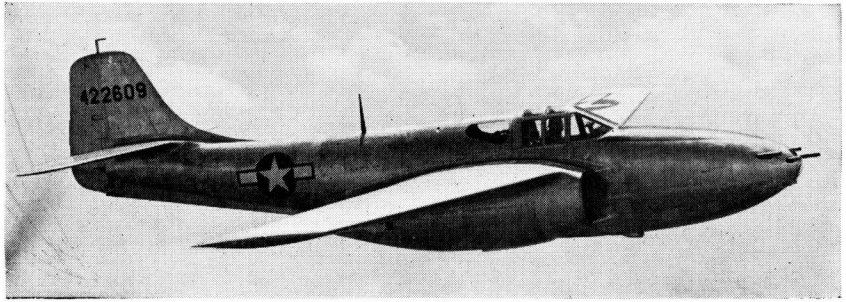
The P-59A Airacomet differed little from the YP-59A, and performance was very similar. Most P-59As were powered by a pair of J31-GE-3 turbojets of 1,650 lb. thrust, but the last few machines received the up-rated J31-GE-5 of 2,000 lb. thrust. The twenty-first and remaining twenty-nine Airacomets built also had J-31-GE-5 units but internal fuel capacity was increased by 55 Imp. gal., and the designation was changed to P-59B. Empty weight of the P-59B was increased to 8,165 lb., and normal and maximum loaded weights were 11,040 lb. and 13,700 lb. respectively. Deliveries of the Airacomet were completed by May 1945. The aircraft had not been a success as a warplane, but it had proved valuable in providing the U.S.A.A.F. with orientation experience with jet aircraft, and in furnishing a nucleus of trained jet pilots.

The following specification relates to the J31-GE-5-powered P-59A Airacomet.

Type: *Single-seat Interceptor Fighter and Fighter-bomber.* **Power Plants:** *Two* 2,000 *lb.s.t. General Electric J31-GE-5 centrifugal turbojets.* **Armament:** *One* 37-*mm. cannon and three* 0.5-*in. machine guns plus two* 1,000-*lb. bombs or eight* 60-*lb. rockets.* **Performance:** *Maximum speed,* 413 *m.p.h. at* 30,000 *ft.,* 380 *m.p.h. at* 5,000 *ft.; maximum cruising speed,* 375 *m.p.h. at* 30,000 *ft.; range* (*on internal fuel at* 60% *power*), 240 *mls. at* 300 *m.p.h. at* 20,000 *ft.,* (*with two* 125 *Imp. gal. drop tanks*), 520 *mls. at* 289 *m.p.h. at* 20,000 *ft.; climb to* 10,000 *ft.,* 3.2 *min., to* 20,000 *ft.* 7.4 *min.; service ceiling,* 46,200 *ft.* **Weights:** *Empty,* 7,950 *lb.; loaded,* 10,822 *lb.; maximum,* 12,700 *lb.* **Dimensions:** *Span,* 45 *ft.* 6 *in.; length,* 38 *ft.* 10 *in.; height,* 12 *ft.* 4 *in.; wing area,* 385.8 *sq. ft.*

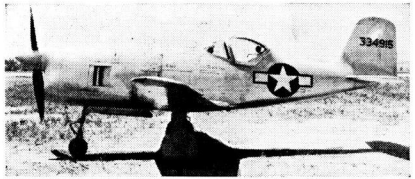
The second production P-59A-1-BE Airacomet (42-2610)

(*Below*) *The first production P-59A-1-BE Airacomet* (42-2609). *This type proved to be a poor gun platform owing to directional snaking, and was relegated to the training role.*

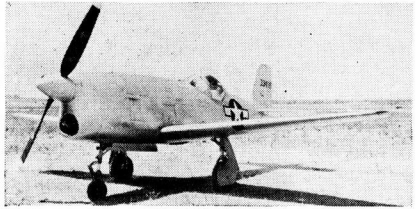


BELL XP-77 — U.S.A.

The war years saw several attempts to safeguard against shortages of light alloys by producing simplified lightweight fighters from so-called "non-strategic" materials such as wood. Noteworthy examples were the French MB-700 (Vol. I, page 35), the Miles M.20 (Vol. II, page 90) and the S.A.I.207 (Vol. II, page 188), and following in their wake came the Bell XP-77. Possessing substantially less power than the French, British or Italian "lightweights", the Bell fighter was first proposed on October 30, 1941, and preliminary design studies were immediately initiated by Bell's chief design engineer, Robert J. Woods, the project then being known as the Tri-4.



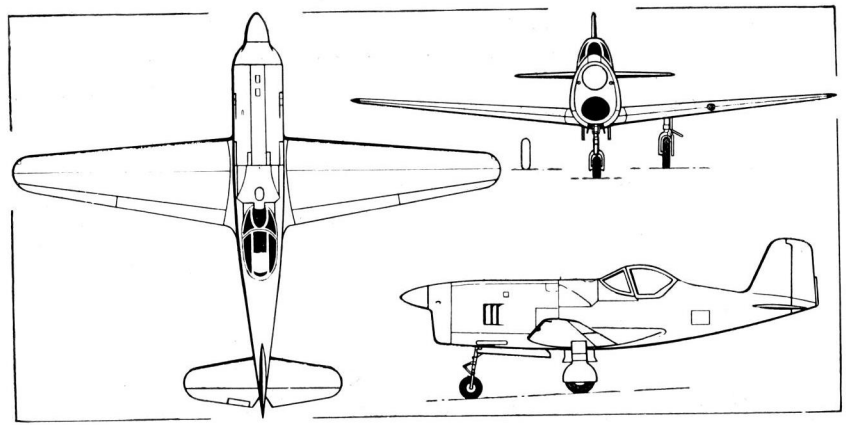
(*Above and below*) *The first XP-77* (43-34915) *wooden lightweight fighter-bomber.*



As first conceived, the Tri-4 was expected to attain 410 m.p.h. at 27,000 ft. on the 500 h.p. offered by a Ranger XV-770-9 twelve-cylinder air-cooled supercharged engine, gross weight being 3,700 lb. and its armament comprising two 20-mm. cannon and two 0.5-in. machine guns. On May 16, 1942, General Arnold authorised the procurement of twenty-five Tri-4 fighters but requested that they be modified to provide for a 300-lb. bomb or a 325-lb. depth charge. As it appeared unlikely that the supercharger-equipped engines would be available for 12–18 months, it was decided that six V-770-6 engines (which offered the same power up to 12,000 ft.) without superchargers would be supplied for initial trials, and the number of Tri-4 fighters reduced to six. On August 20, 1942, by which time the fighter had been redesignated D-6 by Bell, the purchase of six machines under the designation XP-77 was authorised.

It was now obvious to the design team that the guaranteed gross weight of the fighter would have to be revised, with the result that the XP-77 would offer no appreciable advantage in speed, climb and manoeuvrability over production aeroplanes then current. The only solution appeared to be to lighten the aeroplane to 3,000 lb. by means of drastic departures from contemporary requirements. Continual delays and increases in the cost of the programme resulted, on August 3, 1943, in Bell being instructed to complete the construction of two XP-77s which were to be powered by the V-770-7 (the A.A.F. designation for the Navy's V-770-6) and that no further consideration was to be given to the installation of the supercharged V-770-9.

The first XP-77 did not fly until April 1, 1944, but trials at Wright Field revealed unfavourable vibration characteristics at certain



r.p.m. due to the lack of engine-support vibration-damping mounts, the engine being mounted rigidly and directly to the fuselage. Contractors' trials were undertaken with the second XP-77, and this aircraft underwent fuel consumption and operational suitability trials at the A.A.F. Proving Ground at Eglin Field. On October 2, 1944, the aircraft got into an inverted spin as a result of an attempted Immelman and was completely destroyed. Official flight trials were carried out with the first XP-77, but in December 1944 the development contract was terminated.

The XP-77's wing was a single-spar structure with stressed skin and, like the fuselage, was largely of resin-bonded laminated wood. The nosewheel undercarriage was electrically operated and manually-controlled flaps were fitted, but the basic concept that a wooden fighter could be constructed more readily than existing metal fighters was not borne out by the XP-77.

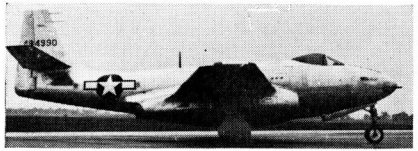
Type: *Single-seat Fighter-bomber.* **Power Plant:** *One* 520 *h.p. Ranger XV-770-7 twelve-cylinder inverted-Vee air-cooled engine.* **Armament:** *Two* 0.5-*in. M2 machine guns with* 200 *r.p.g., and one* 100-*lb.,* 250-*lb., or* 300-*lb. bomb, or one* 325-*lb. depth charge.* **Performance:** *Maximum speed,* 330 *m.p.h. at* 4,000 *ft.,* 328 *m.p.h. at* 12,600 *ft.; initial climb rate,* 3,600 *ft./min.; climb rate at* 2,000 *ft.,* 3,630 *ft./min., at* 9,000 *ft.,* 2,500 *ft./min.; service ceiling,* 30,100 *ft.; range,* 550 *mls. at* 274 *m.p.h.* **Weights:** *Empty,* 2,855 *lb.; normal loaded,* 3,671 *lb., maximum,* 4,028 *lb.* **Dimensions:** *Span,* 27 *ft.* 6 *in.; length,* 22 *ft.* 10⅛ *in.; height,* 8 *ft.* 2¼ *in.; wing area,* 100 sq. ft.

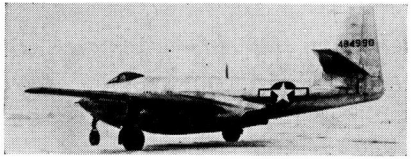
BELL XP-83

U.S.A.

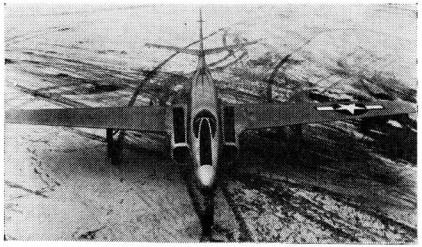
One of the most serious problems presented by the early jet fighters was that of limited operational radius which severely restricted their tactical usage. One of the earliest pure jet fighters of American design intended to overcome this drawback was Bell's XP-83, work on which was initiated in March 1944. The XP-83 retained the basic configuration first employed by the Airacomet, the twin turbojets being installed in a similar fashion beneath the wing roots, adjacent to the fuselage. This arrangement had the advantage that no appreciable asymmetric forces were exerted in the event of one power plant failing, and no fuselage space was occupied by the turbojets, leaving internal capacity free for fuel tanks. In order to achieve the desired range, internal tankage for 957.5 Imp. gal. of fuel was provided, resulting in a singularly large and bulky fuselage. The fuselage tanks could be augmented by a pair of 250 Imp. gal. drop tanks.

A contract for two prototypes of the XP-83 was awarded to Bell on July 31, 1944. A pressurised cabin was provided and proposed armament was six 0.5-in. machine guns in the nose, although alternative schemes for a quartette of 20-mm. or 37-mm. cannon and even a battery of twenty 0.5-in. guns were prepared. The first prototype was flown on February 25, 1945, by Bell's chief test pilot, J. Woolams, but performance did not warrant continuation of development, and the project was abandoned.

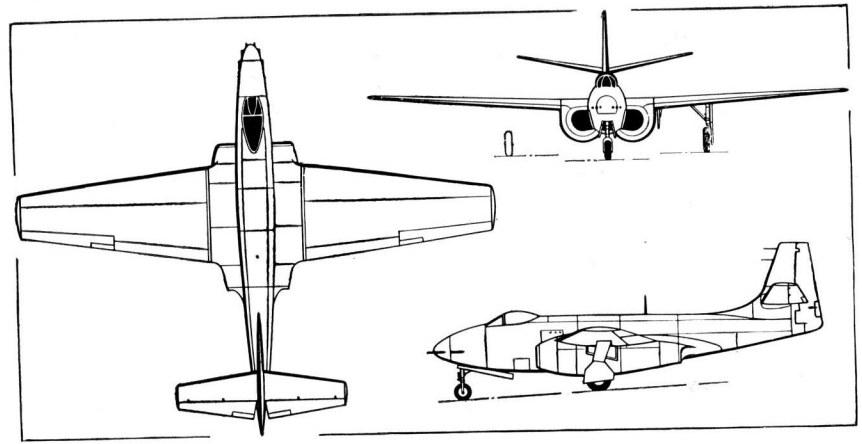


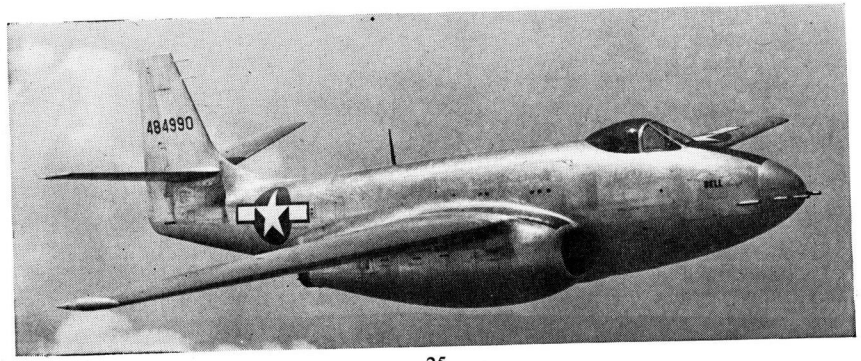


(*Above and below*) *The first XP-83* (44-84990).



Type: *Single-seat Long-range Fighter.* **Power Plants:** *Two* 4,000 *lb.s.t. General Electric J33-GE-5 centrifugal turbojets.* **Armament:** *Six* 0.5-*in. machine guns with* 300 *r.p.g. and two* 2,000-lb. *bombs.* **Performance:** *Maximum speed,* 522 *m.p.h. at* 15,660 *ft.; range* (*internal fuel*), 1,730 *mls. at* 30,000 *ft.,* (*with two* 250 *Imp. gal. drop tanks*), 2,050 *mls.; time to* 30,000 *ft.,* 11.5 *min.; service ceiling,* 45,000 *ft.* **Weights:** *Empty,* 14,105 *lb.; loaded,* 24,090 *lb.; maximum,* 27,500 *lb.* **Dimensions:** *Span,* 53 *ft.* 0 *in.; length,* 44 *ft.* 10 *in.; height,* 15 *ft.* 3 *in.; wing area,* 431 *sq. ft.*





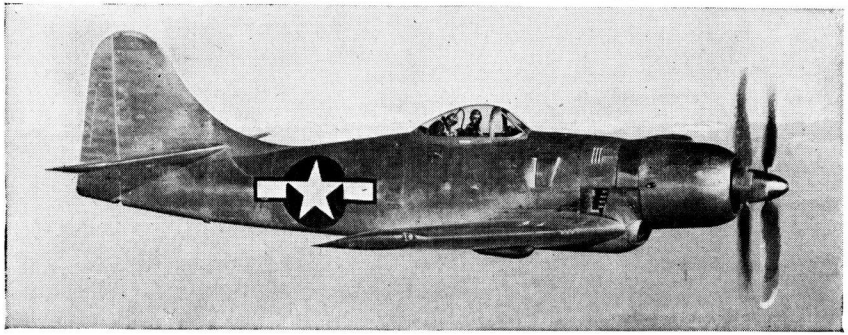
BOEING XF8B-1 U.S.A.

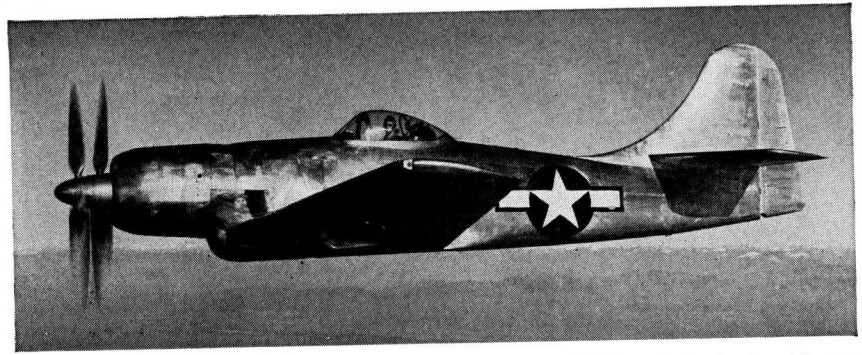
By 1943, the U.S. Navy was preoccupied with a requirement for long-range shipboard aircraft suitable for operation against the Japanese home islands from carriers cruising in the Pacific outside the normal range of Japanese land-based aircraft. The Boeing company designed a large, multi-purpose fighter suitable for such operations and which, on May 4, 1943, was awarded a prototype development contract as the XF8B-1.

The XF8B-1 was the largest and heaviest single-seat, single-piston-engined fighter developed in the U.S.A., and the twenty-eight-cylinder, four-row Pratt and Whitney XR-4360-10 engine was mounted as a power-egg and drove two Aeroprop three-blade contra-rotating airscrews. The XF8B-1 was intended to fulfil the roles of interceptor, long-range escort fighter, dive-bomber, torpedo-bomber and horizontal bomber, and in addition to the alternative built-in armament of six 0.5-in. or six 20-mm. wing-mounted guns, it could carry a 6,400-lb. bomb load or two 2,000-lb. torpedoes under the fuselage and inboard wing panels.

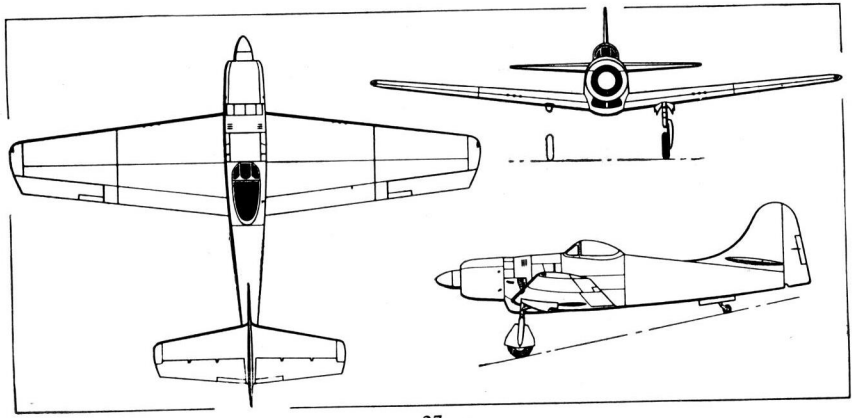
Three prototypes of the XF8B-1 were ordered, but only one of these was completed before the end of the war in the Pacific. The two remaining prototypes were completed after the war, and one of these was evaluated at Wright Field by the U.S.A.A.F.

Type: *Single-seat Shipboard Long-range Interceptor and Fighter-bomber.* **Power Plant:** *One* 3,000 *h.p. Pratt and Whitney XR*-4360-10 *twenty-eight cylinder radial air-cooled engine.* **Armament:** *Six* 0.5-*in. or* 20-*mm. guns and a* 6,400-*lb. bomb load.* **Performance:** *Maximum speed,* 340 *m.p.h. at sea level,* 432 *m.p.h. at* 26,900 *ft.; normal range,* 1,305 *mls.; maximum range,* 2,780 *mls.; initial climb rate,* 2,800 *ft./min.; service ceiling,* 37,500 *ft.* **Weights:** *Empty,* 13,519 *lb.; loaded,* 20,508 *lb.; maximum permissible,* 21,691 *lb.* **Dimensions:** *Span,* 54 *ft.* 0 *in.; length,* 43 *ft.* 3 *in.; height,* 16 *ft.* 3 *in.; wing area,* 489 *sq. ft.*





The XF8B-1 was one of the most powerful single-piston-engined fighters to be developed by any nation during the Second World War.

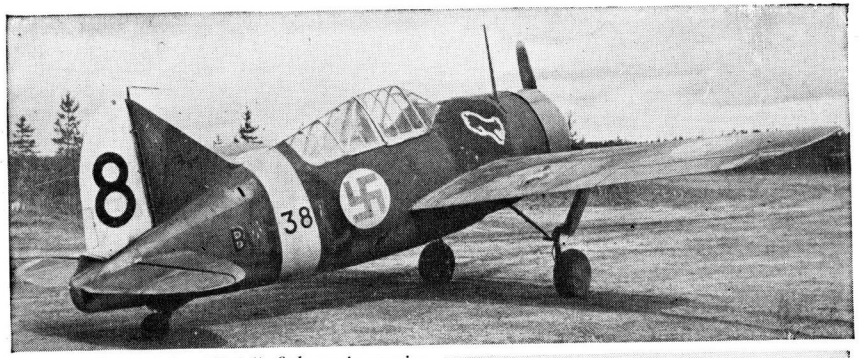


BREWSTER F2A (BUFFALO) U.S.A.

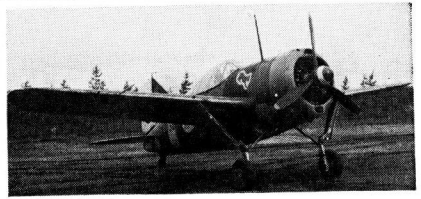
Early in 1936, the U.S. Navy began to realise that the shipboard fighter biplane was rapidly approaching its performance peak and that any future gains would be marginal. Several manufacturers were, therefore, requested to submit their proposals for shipboard fighter monoplanes embodying such refinements as retractable undercarriages and enclosed cockpits. The Seversky Aircraft Corporation offered a navalized version of the Army Air Corps' P-35, a prototype of which was ordered as the XFN-1, and the Brewster Aeronautical Corporation prepared an original design which was ordered on June 22, 1936, as the XF2A-1. To safeguard against the failure of the shipboard monoplane, the Grumman Aircraft Engineering Corporation had designed a competitive fighter biplane which had been ordered some four months earlier, on March 2, 1936, as the XF4F-1. In the event, however, the Grumman project was re-started as the XF4F-2 fighter monoplane.

Possessing the manufacturers' designation B-139, the Brewster fighter was designed by

A Brewster F2A-2 photographed in August 1942. This type had an undistinguished career with the U.S. Navy.

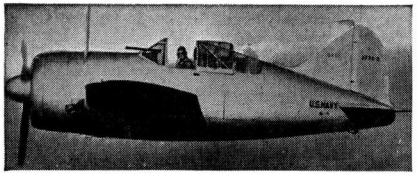


Brewster B-239 (alias F2A-1) fighters in service with the Finnish Air Force. These remained in first-line service until the summer of 1944.



Dayton T. Brown and R. D. MacCart, and flight trials began in January 1938. The XF2A-1 was powered by a Wright XR-1820-22 Cyclone engine rated at 950 h.p. for take-off and 750 h.p. at 15,200 ft., and attained a maximum speed of 277.5 m.p.h. at 15,200 ft. Of relatively advanced conception, it was a mid-wing cantilever monoplane of all-metal construction with a flush-riveted metal stressed skin and metal-framed, fabric-covered control surfaces. Hydraulically-operated split flaps were mounted between the ailerons and the fuselage, and armament comprised one 0.3-in. and one 0.5-in. machine gun. Evaluation trials were successful and, on June 11, 1938, Brewster received an order for fifty-four F2A-1 (B-239) fighters powered by the R-1820-34 engine offering 940 h.p. for take-off and 750 h.p. at 17,000 ft. Empty and normal loaded weights were increased from 3,711 lb. and 5,017 lb. to 3,785 lb. and 5,055 lb., and maximum speed was raised to 301 m.p.h. at 17,000 ft. Initial climb rate was 3,060 ft./min., service ceiling was 32,500 ft., and normal range was 1,095 mls.

Deliveries of the F2A-1 began in June 1939, eleven of these reaching the U.S. Navy to become that service's first fighter monoplanes, and nine were assigned to VF-3, the U.S. Navy's senior fighter squadron, operating from the U.S.S. *Saratoga*. In the meantime, on March 22, 1939, the U.S. Navy had ordered the



The Brewster XF2A-2 (originally XF2A-1).

installation in the original prototype of the R-1820-40 which offered 1,200 h.p. for take-off and 900 h.p. at 14,000 ft. An electric airscrew with spinner and cuffs supplanted the hydraulic airscrew; the fuel tank was redesigned for a high-pressure carburettor system and high-altitude operation; improved integral flotation gear was introduced, and an escape hatch was fitted in the sliding canopy. Redesignated XF2A-2, the prototype's empty and normal loaded weights rose to 4,131 lb. and 5,409 lb. but maximum speed was boosted to 325 m.p.h. at 16,100 ft.

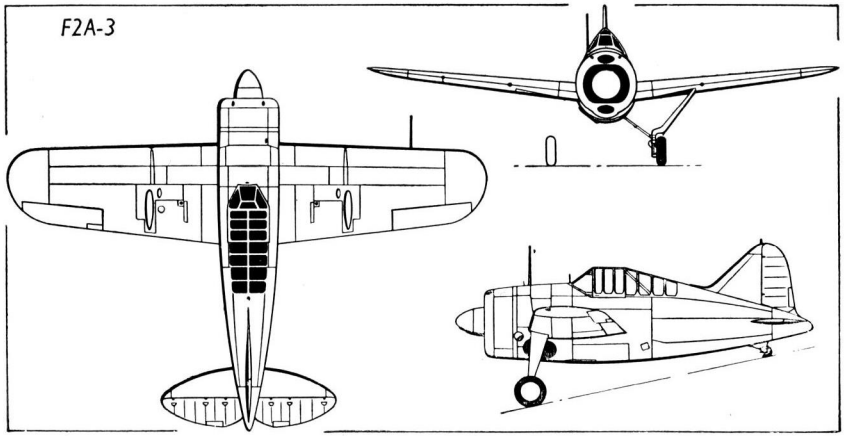
Trials with the XF2A-2 began in July 1939, some months before the U.S. Navy accepted its first F2A-1s, and in December 1939, as a result of American sympathies for the Finns in their "David and Goliath" struggle with the Soviet Union, the remaining forty-three F2A-1s still to be delivered to the U.S. Navy were officially declared surplus to requirements as a means of making them available for delivery to Finland. To replace these, an order for forty-three F2A-2s was placed on behalf of the U.S. Navy. In fact, *forty-four* F2A-1 (alias B-239) fighters were shipped to Sweden where they were reassembled by SAAB's Trollhättan plant, tested and then flown to Finland. The F2A-1 contract was completed in February 1940, and all the Brewster fighters had reached Finland by the following April. They were, of course, too late to participate in the "Winter War" but, stripped of their arrester gear and other naval equipment, they re-equipped Nos. 24 and 26 Squadrons of the Finnish Air Regiment LeR 2 and, when hostilities between Finland and Russia were resumed, they were employed with surprising success, remaining in first-line service until the summer of 1944.

Deliveries of the F2A-2 followed on those of the F2A-1 but U.S. Navy acceptances did not begin until September 1940 as the first F2A-2 was subjected to a considerable number of minor changes, some of which were associated with engine overheating. This aircraft was also tested in the fighter-bomber role, two 100-lb. bombs being released satisfactorily in a 60° dive at 386 m.p.h. The thirtieth F2A-2 was also used for trials and was the first "combat modification" aircraft, having two 0.5-in. guns in the fuselage and two similar guns in the wings, some armour and a protected fuel tank. During trials this machine attained 326 m.p.h. at 14,500 ft., and, after modifications, 320 m.p.h. at 34,400 ft.

In the meantime, the Brewster Aeronautical Corporation had obtained several export orders for land-based variants of the fighter. A Belgian Purchasing Mission ordered forty machines under the designation B-339, and a British Mission ordered a further 170 fighters under the designation B-339E, allocating the name "Buffalo" to the type. The B-339 and B-339E were essentially similar apart from instrumentation and minor items of equipment, but deliveries of the former began too late to reach Belgium before that country had been overrun. One or two crated machines reached Bordeaux-Merignac in June 1940, being subsequently captured by the Germans, and six other Belgian B-339s were being ferried to Europe aboard the old French carrier *Berne* at the time of France's collapse. The carrier was diverted to Martinique

where the B-339s were disembarked, eventually mouldering away in the open. The remainder of the Belgian contract was taken over by the British government, the B-339s being delivered to the Fleet Air Arm. Some six of these were eventually taken on strength by No. 805 Squadron and operated alongside Fairey Fulmars from March 1941, being despatched to Crete to provide fighter cover for the naval base at Suda Bay. The B-339s proved totally inadequate for operational purposes, however, and it is doubtful if they ever saw combat.

The first few B-339E Buffalo fighters of the 170 ordered by the British Mission were shipped to the United Kingdom where trials were undertaken by No. 71 Squadron, but the type was rejected for first-line European operational service. However, Nos. 21 and 453 Squadrons of the R.A.A.F., Nos. 67 and 243 Squadrons of the R.A.F., and No. 488 Squadron of the R.N.Z.A.F. were equipped with the Buffalo in Malaya for the defence of Singapore and the Straits Settlements. The substantial increase in wing loading which had resulted from the addition of armour protection, heavier armament and extra operational equipment had adversely affected the manoeuvrability, climb rate and ceiling of the Buffalo. In fact, it had become an extremely unstable aeroplane requiring nearly thirty minutes to attain 21,000 ft. in fully loaded condition. It was thus no match for the Japanese fighters that it attempted to oppose. In order to obtain a marginal performance improvement, 0.303-in. guns were installed



in place of the heavier 0.5-in. guns, ammunition capacity was reduced and fuel was severely restricted, but the Buffalo still faired badly at the hands of the Japanese and, after the fall of Singapore, the handful of surviving fighters of this type co-operated with the American Volunteer Group in the aerial defence of Burma.

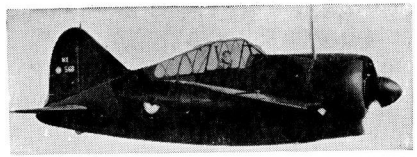
During 1940, in an attempt to bolster the Royal Netherlands Indies Army Air Corps, seventy-two of the Brewster fighters were ordered under the designation B-339D, acceptances commencing in March 1941. A supplementary order for twenty examples of a more powerful version, the B-439, was later placed by the Dutch, but deliveries of these were not effected before the capitulation. Whereas the B-339D was fitted with the GR-1820-G105A Cyclone rated at 1,100 h.p. for take-off and similar to the engine installed in the B-339E Buffalo, the B-439 had the GR-1820-G205A rated at 1,200 h.p. for take-off and 1,000 h.p. at 14,200 ft. Thirty B-339D fighters were in first-line Dutch service on December 8, 1941 when the Netherlands declared war on Japan, and under the Anglo-Dutch Mutual Defence Agreement, a squadron was despatched to Malaya where it saw action for the first time on January 12, 1942. The B-339Ds were not fitted with an armoured windscreen and, consequently, the windscreens were removed from damaged B-339E Buffalos and fitted to the Dutch fighters. The five survivors of the fighting over Malaya were withdrawn to Sumatra. A further twenty B-339Ds had been in reserve on December 8, 1941, and these were continuously in action against the Japanese over Ambon, Borneo and Java, only four

The Brewster F2A-2 (below) and F2A-3 opposed the Japanese at Midway but proved ineffective.

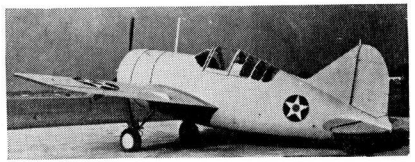
damaged machines being left when Java capitulated. During the fighting in the Netherlands Indies, B-339Ds equipped with two 100-lb. bombs sank a Japanese destroyer and damaged a number of freighters.

On January 21, 1941, the U.S. Navy had ordered a further 108 Brewster fighters under the designation F2A-3, this order being placed primarily to keep the Brewster production line occupied. At this time the F2A-2 was entering service with U.S. Navy fighter squadrons, and this model, similarly powered to the XF2A-2, attained 285 m.p.h. at sea level and 323 m.p.h. at 16,500 ft. Service ceiling was 34,000 ft., normal range was 1,015 mls., and empty and normal loaded weights were 4,576 lb. and 5,942 lb., maximum overload weight being 6,890 lb. The F2A-3 featured increased armour protection for the pilot and fuel tank, an armoured windscreen and later radio. Further increases in weight adversely affected performance. In September–October 1941, fourteen F2A-2s and eighteen F2A-3s were with U.S. Navy Squadron VF-2, and nine F2A-2s and five F2A-3s were with VF-3, while the Marine Fighter Squadron VMF-221 had three F2A-2s and eleven F2A-3s, but the fighter's subsequent operational career with the U.S. Navy and Marine Corps was undistinguished, and the twenty-one aircraft of this type that opposed the Japanese assault on Midway Island were shot to pieces, the Mitsubishi Zero-Sen fighter being infinitely more manoeuvrable.

One machine was experimentally fitted with a pressure cabin as the XF2A-4, but production of the Brewster fighter terminated in March 1942 with the completion of the last of the twenty Dutch B-439s which brought total deliveries to 507 aircraft. The following specification relates to the F2A-3, details in parentheses relating specifically to the B-339E Buffalo I as used by the R.A.F., the R.A.A.F., and the R.N.Z.A.F.



(Above) A Belgian B-339 fighter under test in the U.S.A. A small number of Belgian B-339s were taken over by Britain and issued to the Navy's No. 805 Squadron.



(Above) An early production Brewster F2A-3.

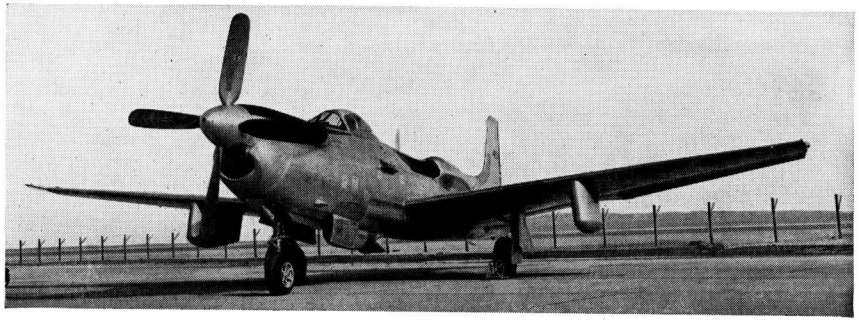
Type: *Single-seat Interceptor and Fighter-bomber.* **Power Plant:** *One* 1,200 (1,100) *h.p. Wright R-1820-40 (GR-1820-G105A) nine-cylinder radial air-cooled engine.* **Armament:** *Four* 0.5-*in. Colt-Browning machine guns and two* 100-*lb. bombs.* **Performance:** *Maximum speed,* 321 (313) *m.p.h. at* 16,500 (13,500) *ft., 284 m.p.h. at sea level; maximum cruising speed,* 258 (255) *m.p.h.; economical cruising speed,* 161 *m.p.h.; normal range* 965 (520) *mls.; maximum range,* 1,680 (840) *mls.; initial climb rate,* 2,290 (2,070) *ft./min.; service ceiling,* 33,200 (30,675) *ft.* **Weights:** *Empty,* 4,732 (4,479) *lb.; normal loaded,* 6,321 (6,840) *lb.; maximum,* 7,159 *lb.* **Dimensions:** *Span,* 35 *ft.* 0 *in.; length,* 26 *ft.* 4 *in.; height,* 12 *ft.* 1 *in.; wing area,* 208.9 *sq. ft.*

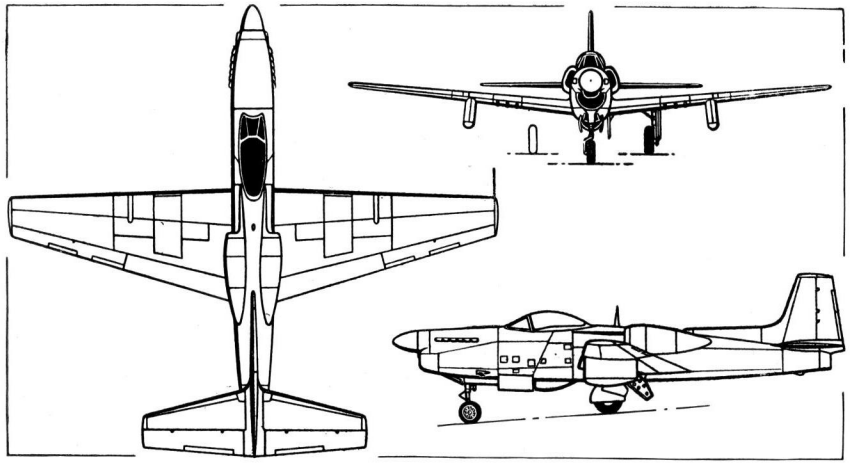
CONSOLIDATED-VULTEE XP-81 U.S.A.

The principal limitation of early jet fighters was that of range, and in an attempt to couple the improved performance offered by the turbojet with the long endurance demanded by the Pacific campaign, the Consolidated Vultee Aircraft Corporation began design work on a unique long-range fighter on January 5, 1944, receiving an order for two prototypes designated XP-81 on February 11th of that year. The XP-81 was designed to take a General Electric TG-100 (later redesignated XT31) turboprop in the nose, driving a four-blade airscrew, and an Allison-built J33-GE-5 turbojet in the rear fuselage, the turboprop being employed for cruising and the power of the turbojet being added for high-speed flight.

The first XP-81 (44-91000) was completed in January 1945, but the TG-100 turboprop was suffering teething troubles and was not immediately available for installation. It was therefore suggested that a standard Packard Rolls-Royce Merlin piston-engine should be mounted in the nose for initial flight trials. A complete V-1650-7 Merlin packaged power section for a P-51D Mustang was supplied by the U.S.A.A.F., and the necessary modifications were effected in little more than a week. A special engine mount was made to pick up the Merlin attachment points and those in the XP-81 for the TG-100, the coolant radiator was placed in the position to have been occupied by the exhaust pipe of the turboprop, and the P-51D airscrew was retained. After ground tests, the XP-81 was sent to Muroc where it was flown for the first time on February 11, 1945. Ten hours of flight testing were conducted at Muroc where the XP-81 evinced exceptionally fine handling characteristics.

Thirteen pre-production YP-81s had been ordered, but the capture of Guam, Saipan and other Pacific islands removed the need for long-range, high-speed escort fighters, and shortly before V-J Day, when engineering was some eighty-five per cent complete, the YP-81





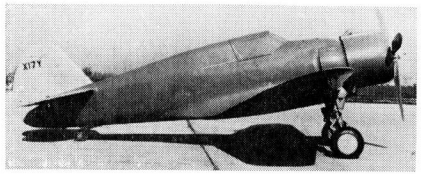
contract was cancelled. The YP-81 was to have been essentially similar to the XP-81, apart from having the lighter and more powerful TG-110 turboprop in the nose, the wing moved aft ten inches, and an armament of six 0.5-in. machine guns or six 20-mm. cannon. The first XP-81 was eventually flown back to Vultee Field to be re-engined with the TG-100 turboprop, but flight trials were not resumed until after the cessation of hostilities, the initial test being made on December 21, 1945. The TG-100 was expected to offer 2,300 e.h.p. but in fact produced little more than 1,400 e.h.p., restricting the fighter's performance to approximately that of the machine when fitted with the 1,490 h.p. V-1650-7 Merlin. No details of the performance actually attained under test are available, and the following specification includes estimated performance based on anticipated engine power.

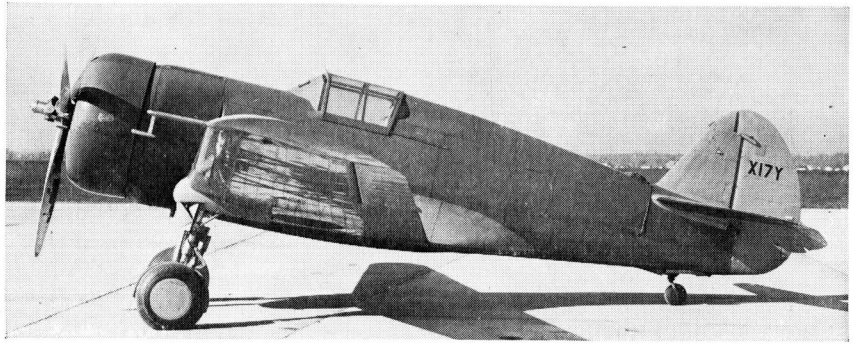
Type: *Single-seat Long-range Escort Fighter.* **Power Plants:** *One* 2,300 *e.h.p. General Electric XT*31*-GE-*1 (*TG-*100) *turboprop and one* 3,750 *lb.s.t. Allison J*33*-GE-*5 *turbojet.* **Armament:** (*Proposed*) *Six* 0.5*-in. machine guns or six* 20*-mm. cannon and two* 1,600*-lb. bombs.* **Performance:** *Maximum speed,* 478 *m.p.h. at sea level,* 507 *m.p.h. at* 30,000 *ft.; range,* 2,500 *mls. at* 275 *m.p.h. at* 25,000 *ft.; initial climb rate,* 5,300 *ft./min.; service ceiling,* 35,500 *ft.* **Weights:** *Empty,* 12,755 *lb.; loaded,* 19,500 *lb.; maximum overload,* 24,650 *lb.* **Dimensions:** *Span,* 50 *ft.* 6 *in.; length,* 44 *ft.* 10 *in.; height,* 14 *ft.* 0 *in.; wing area,* 425 *sq. ft.*

CURTISS P-36 (HAWK 75A) U.S.A.

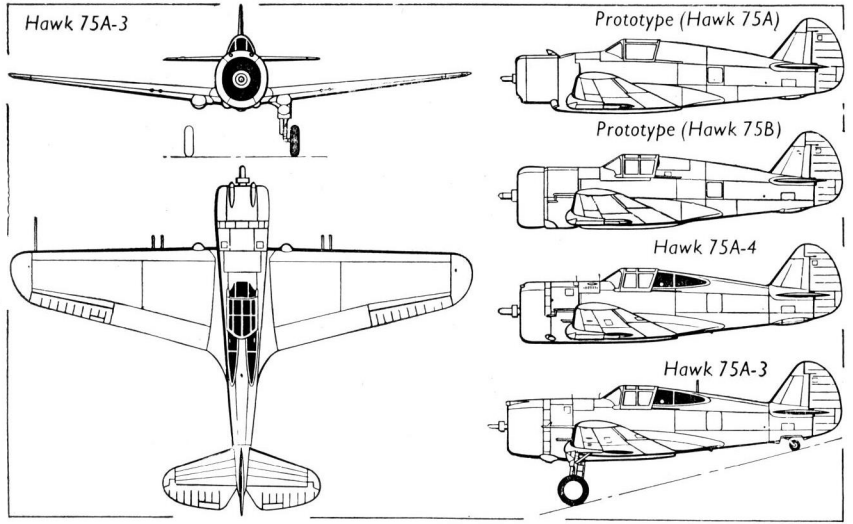
In anticipation of a U.S.A.A.C. requirement for a single-seat interceptor to replace the Boeing P-26A, Don Berlin, the Chief Engineer of the Curtiss-Wright Corporation's Airplane Division, initiated a design study for an advanced low-wing, all-metal fighter monoplane with a monocoque fuselage, hydraulically-actuated split flaps and a fully retractable undercarriage. Known as the Curtiss Design 75 and powered by a 900 h.p. Wright XR-1670-5 two-row air-cooled radial, the fighter was a contemporary of the Hawker Hurricane, the Supermarine Spitfire and the Messerschmitt Bf 109, the design of all four aircraft being started in 1934. Prototype construction began in November 1934, and on May 27, 1935, the design was submitted for entry in the U.S.A.A.C. Material Division's single-seat pursuit contest which was originally to have been held that month. As none of the competing designs were ready for evaluation at this time, the contest was deferred until August, and then until April 1936, by which time the Curtiss prototype had been re-engined with an 850 h.p. Wright XR-1820-39 (G5) single-row radial as the Design 75-B.

The Design 75-B had empty and loaded weights of 4,049 lb. and 5,075 lb. respectively,





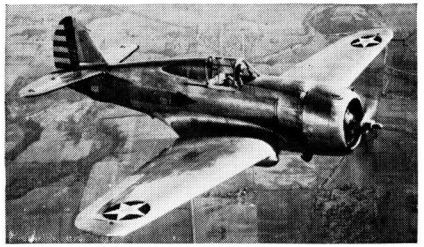
(Left) The Design 75 in its original form and (below) after modification as the Design 75-B.

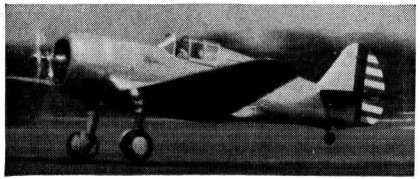


and the manufacturers guaranteed a maximum speed of 294 m.p.h. at 10,000 ft. However, the XR-1820 power plant proved troublesome, necessitating four engine changes during the course of official trials and failing to provide full rated power, resulting in a maximum speed of only 285 m.p.h. The contest was won by the competitive Seversky design, but in July 1936 Curtiss received a contract for three service test examples of their fighter which, designated Y1P-36 (and later redesignated P-36) were to be powered by the Pratt and Whitney R-1830 Twin Wasp engine.

The first Y1P-36 was completed in March 1937, and successfully passed official trials at Wright Field during the following summer. Powered by an R-1830-13 Twin Wasp derated from 1,050 h.p. to 950 h.p. for take-off and driving a Hamilton Standard constant-speed airscrew, the Y1P-36 was tested at a gross weight of 5,437 lb., empty weight being 4,389 lb., and maximum speeds of 294.5 m.p.h. at 10,000 ft. on 900 h.p. and 256 m.p.h. at the same altitude on 660 h.p. were recorded during these trials.

The excellent results achieved at Wright Field led to the placing of an order for 210 production P-36A fighters on July 7,1937, these



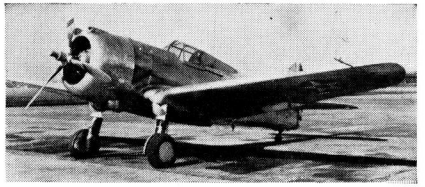


(Above and left) The Y1P-36 and (below, left) a Y1P-36 with contra-rotating airscrews.

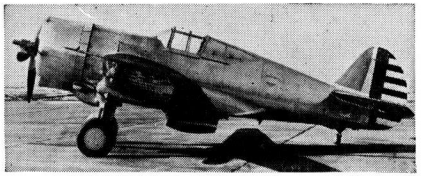
being essentially similar to the service test machines apart from the use of a Curtiss constant-speed airscrew and a fully-rated R-1830-13 Twin Wasp engine. The first P-36A was delivered to the U.S.A.A.C. in April 1938, and weighing 5,470 lb. loaded and carrying an armament of one 0.3-in. gun with 500 rounds and one 0.5-in. gun with 200 rounds, attained a maximum speed of 313 m.p.h. at 10,000 ft. By June 1939 Curtiss had made eighty-one factory changes on the P-36A, some of which were of a major nature, as a result of which loaded weight rose to 5,650 lb. and maximum speed dropped to 300 m.p.h. at 10,000 ft.

Prior to the completion of the U.S.A.A.C. production contract in June 1939, a considerable amount of development and experimentation with the basic design had taken place. One P-36A was fitted with a 1,000 h.p. R-1830-25 engine as the P-36B, while the last

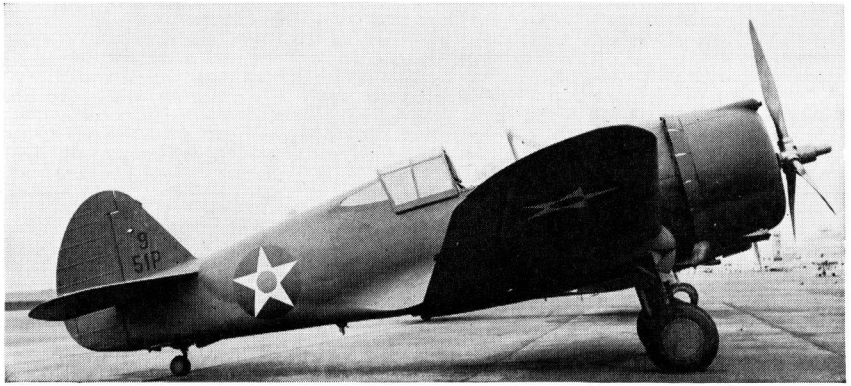
thirty-one P-36As were completed as P-36Cs with the R-1830-17 (S1C3-G) Twin Wasp rated at 1,200 h.p. for take-off and 1,050 h.p. at 10,000 ft., armament being increased by the addition of two 0.3-in. wing guns with 500 r.p.g. Empty and loaded weights were increased to 4,620 lb. and 5,734 lb. respectively, and performance included a maximum speed of 311 m.p.h. at 10,000 ft., a range of 600 mls. at 270 m.p.h. at 10,000 ft., and 820 mls. at 200 m.p.h., the ability to climb to 15,000 ft. in 4.9 min., and a service ceiling of 32,000 ft. The XP-36D, XP-36E and XP-36F were all single experimental conversions of P-36As for armament trials; the XP-36D having two fuselage-mounted 0.5-in. guns with 400 r.p.g. and four wing-mounted 0.3-in. guns with 500 r.p.g.; the XP-36E having one fuselage-



(Above) The sole P-36B which featured an R-1830-25 engine.



(Right) The turbo-supercharged Hawk 75-R and (below) a P-36A of the 51st Pursuit Group.



mounted 0.5-in. gun with 200 rounds and eight wing-mounted 0.3-in. guns with 500 r.p.g., and the XP-36F having two fuselage-mounted 0.3-in. and 0.5-in. guns and two 23-mm. Madsen cannon mounted under the wings with 100 r.p.g.

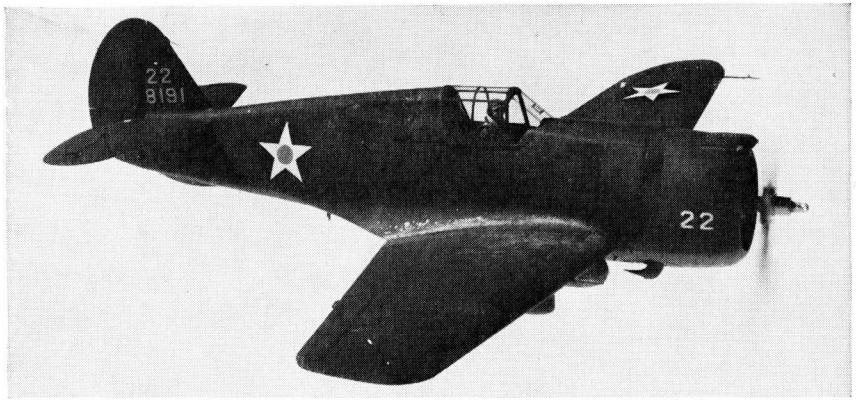
Other experimental conversions of P-36A airframes were concerned primarily with power plant trials, and while the original service Y1P-36s were under construction parallel work had been conducted on re-working the basic Model 75 design to incorporate a 1,150 h.p. Allison V-1710-11 turbo-supercharged liquid-cooled engine. Known by the manufacturers' designation Hawk 75-I, this variant was submitted to the A.A.C. on April 1, 1937, and received the official designation XP-37. Thirteen YP-37s were built for service evaluation with the Allison V-1710-21 engine, but when the first of these flew in June 1939 it failed to attain the guaranteed 340 m.p.h. By that time it had, in any case, been superseded by the XP-40, a straightforward conversion of the tenth production P-36A airframe to take an Allison V-1710-19 (C13) engine.

Another experimental conversion of a P-36A airframe was the XP-42 which was intended to test various engine cowling designs. Initially, the XP-42 was fitted with an extension shaft to its 1,050 h.p. R-1830-31 air-cooled radial and a long-nose, high-inlet-velocity cowling somewhat similar to that tested some six months later on the Vultee Model P-48 (see page 195). Trials began in March 1939, and during the course of testing it was fitted with various types of cowl flaps, and short-nose high- and low-inlet-velocity cowlings with and without fans.

The operational career of the P-36 with the U.S.A.A.F. was short-lived. Already considered to be obsolete when Japanese forces attacked Pearl Harbour, thirty-nine P-36A fighters were stationed at various bases in the Hawaiian Islands with the 46th and 47th Pursuit Squadrons, the latter being in process of conversion to the P-40 on December 7, 1941. They participated in the first retaliation sorties against the Japanese, and P-36As of the 46th Squadron were responsible for the first A.A.F. "kills" of the Pacific War, but apart from equipping reserve units for a brief period, this fighter was subsequently relegated to the pursuit training role.

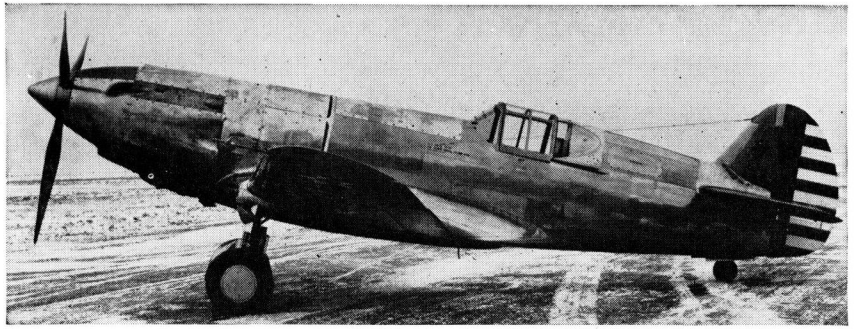
The export versions of the basic design saw more active service, however, for under the designation Hawk 75A, fighters of this type provided the Armée de l'Air with its first victories over the Western Front. This event took place on September 8, 1939, when five Hawk 75A-1 fighters of the Groupe de Chasse II/4 destroyed two Bf 109Es. In May 1938 a French Purchasing Mission had placed an order for 100 Hawk 75A-1 fighters powered by the 1,050 h.p. Pratt and Whitney R-1830-SC3-G Twin Wasp, these differing from the P-36A fighters then being delivered to the U.S.A.A.C. only in having an armament of four 7.5-mm. FN-built Browning guns, a throttle operating in the reverse direction to those of American machines, metric-calibrated instruments, a modified seat to accommodate a French Lemercier back-parachute, a Radio-Industrie-537 radio set, a Baille-Lemaire gun-sight, and a Munerelle oxygen supply. The first and second Hawk 75A-1 fighters reached Le Havre on December 24, 1938, after having been tested at Buffalo. These were sent to the SN.C.A.C. plant at Bourges for checking, as were also the next fourteen machines. Subsequent Hawk 75A-1s were shipped in disassembled form and assembled at Bourges from February 1939. In March 1939 the 4e and 5e Escadres de Chasse (these units later becoming GC I/4, II/4, I/5 and II/5) based at Reims began converting to the American fighter.

During 1939 supplementary orders were

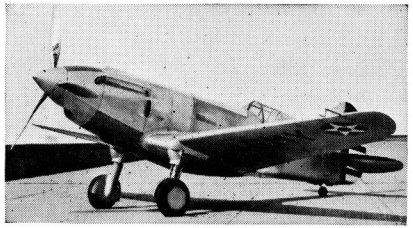


The last thirty-one P-36As were completed as P-36Cs (as above) with the R-1830-17 Twin Wasp.

placed for 100 Hawk 75A-2s and 135 Hawk 75A-3s, the former differing from the A-1 in having two additional 7.5-mm. guns in the wings, and the latter having the same six-gun armament but an R-1830-S1C3-G Twin Wasp rated at 1,200 h.p. for take-off and 1,050 h.p. at 7,500 ft. These orders were followed by another for no less than 395 Hawk 75A-4s with the Wright GR-1820-G205A Cyclone 9 engine rated at 1,200 h.p. for take-off and having the same military rating at 4,200 ft. Only 291 Hawk 75A fighters were actually taken on strength by the Armée de l'Air before the collapse of French resistance, but a number were lost en route to French ports, and seventeen were disembarked in Martinique in June 1940, and a further six in Guadeloupe, these being Hawk 75A-4s. These machines were, incidentally, shipped from the West Indies to Morocco during 1943–44, placed in flying condition and used for training, their unreliable Cyclone 9 engines being replaced by Twin Wasps. All 200 Hawk 75A-1s and A-2s reached France, and the bulk of the remaining machines taken on strength by the Armée de l'Air were Hawk 75A-3s, although a small number of Cyclone 9-powered Hawk 75A-4s also joined combat. The Hawk 75As served with GC III/2 which converted to the fighter in June 1940, GC I/4, GC II/4, GC I/5 and GC II/5, these units claiming 230 confirmed "kills" and eighty-one "probables" before June 24, 1940. After the Armistice, GC I/4 and I/5 continued flying their Hawk 75As with the Vichy Air Force, the former based at Dakar and the latter at Rabat.

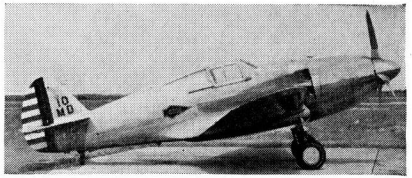


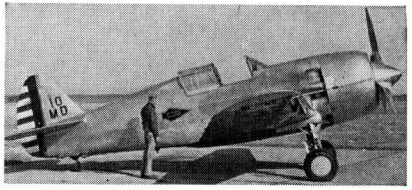
(*Above*) *One of the thirteen YP-37s built for service evaluation and* (*below, left*) *the XP-37.*



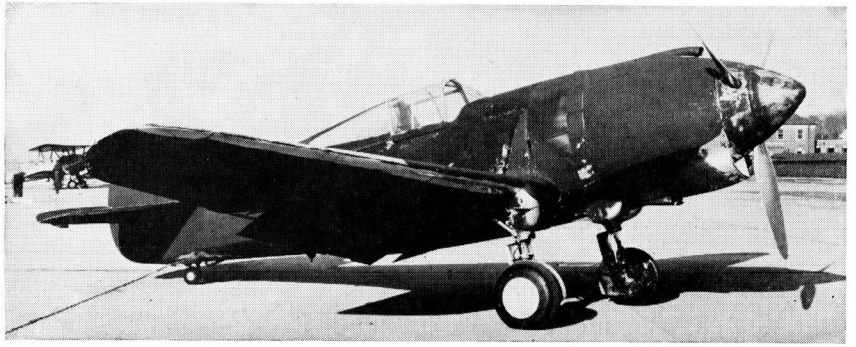
A number of Armée de l'Air Hawk 75As were captured by the German forces, some still in their delivery crates, and these were transported to Germany where they were overhauled and assembled by the Espenlaub Flugzeugbau, fitted with German instrumentation, and then sold to Finland. The Finnish Air Force received thirty-six Hawk 75A-1s, A-2s, and A-3s, and also eight Norwegian Hawk 75A-6s. In the autumn of 1939 the Norwegian government had placed an order for twelve Hawk 75A-6s powered by the R-1830-SC3-G Twin Wasp, these being basically similar to the A-3 apart from their armament of four 7.9-mm. guns. This order was later supplemented by another for a further twelve, and some of these had actually reached Norway before that country was overrun, being found there in their shipping crates by the Germans. The Norwegian government also ordered thirty-six Hawk 75A-8 fighters powered by the Wright GR-1820-G205A (87) Cyclone 9 and armed with two 12.7-mm. and four 7.9-mm. guns. These were seized by the U.S. government with the occupation of Norway and given the designation P-36G. Twenty-eight of them were later supplied to Peru under Lend-Lease, and the others, together with the non-delivered Hawk 75A-6s, were delivered to "Little Norway", the Norwegian training establishment near Toronto, Canada, for use as fighter trainers.

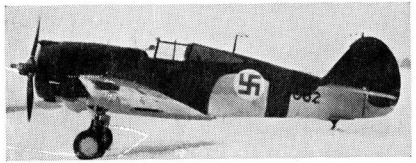
With the fall of France, outstanding French contracts were hurriedly transferred to Britain and, as a result, the R.A.F. received 227 Hawk 75A fighters originally intended for the Armée de l'Air. The type was promptly dubbed 'Mohawk', and Hawk 75A-3s powered by the GR-1830-S1C3-G Twin Wasp were designated Mohawk III and Hawk 75A-4s with the GR-1820-G205A Cyclone 9 were designated Mohawk IV. Earlier Twin Wasp-powered models taken over in the field were designated Mohawk I and II. Those shipped direct to the United Kingdom were fitted with six 0.303-in. Browning guns and British equipment, and then held in reserve at various R.A.F. maintenance units until, at the end of 1941, they were shipped to India for use by the Indian Air Force. At one period, eight Mohawks provided the sole fighter defence of North-East India, and the fighter remained operational on the Burma Front until finally re-



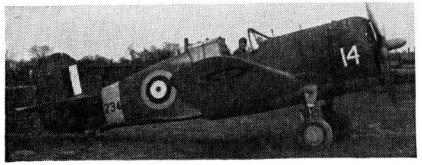


The XP-42 with various types of engine cowling. (*Top, right*) *The XP-42 with initial long-nose high-inlet-velocity cowling.* (*Below, right*) *With short-nose low-inlet-velocity cowling, and* (*below*) *with final cowling.*





(*Above*) *A Finnish Hawk 75A-3 and* (*below*) *a Mohawk IV.*



placed in December 1943. In April 1941 the Indian government had placed a contract with Hindustan Aircraft for the construction of forty-eight Cyclone 9-powered Hawk 75As together with the necessary spares. A manufacturing licence was obtained, and the first Indian-built machine was completed and flown on July 31, 1942. However, shortly after this event, a change in policy resulted in the decision to abandon the construction of complete aircraft in India, and after the delivery of four additional machines the project terminated. Those Mohawks not shipped to India were supplied to the South African Air Force, being operated by No. 3 Squadron in East Africa, and, in the autumn of 1941, others were supplied to the Portuguese Air Force. The Iranian government had ordered ten Cyclone 9-powered Hawk 75A-9 fighters which reached Iran shortly before that country was occupied by British and Russian forces on August 25, 1941. The Hawk 75A-9s were discovered still in their shipping crates, transported to the maintenance unit at Drigh Road, Karachi, where they arrived early in 1942, and subsequently issued to No. 5 Squadron, the first R.A.F. unit to operate the Mohawk in the Far East.

One other export order for the Hawk 75A which did not reach the hands for which it was originally intended was that placed by the Netherlands government for the Hawk 75A-7, another Cyclone 9-powered model. The original order was for thirty-five machines, but this was reduced to twenty-four and, as these did not reach the Netherlands before the German invasion of that country, they were diverted to the Netherlands East Indies where they arrived in 1940, entering service with the Army Air Corps and participating in the resistance against the invading Japanese.

The following specification relates to the P-36C (which was basically similar to the Hawk 75A-3 and Mohawk III), figures in parentheses relating to the Hawk 75A-4 (essentially similar to the P-36G and Mohawk IV).

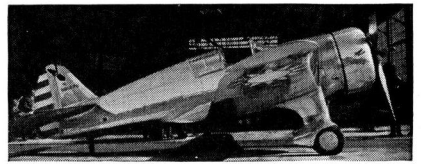
Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 1,200 *h.p. Pratt and Whitney R-1830-17 Twin Wasp* (*Wright GR-1820-G205A Cyclone 9*) *fourteen-* (*nine-*) *cylinder radial air-cooled engine.* **Armament:** *Three* 0.3-*in. and one* 0.5-*in. machine guns* (*six* 7.5-*mm. FN-Browning machine guns*). **Performance:** *Maximum speed,* 311 (323) *m.p.h. at* 10,000 (15,100) *ft.; maximum cruising speed,* 270 (262) *m.p.h.; range,* 820 (603) *mls. at* 200 (248) *m.p.h.; time to* 15,000 *ft.,* 4.9 *min.; service ceiling,* 33,700 (32,700) *ft.* **Weights:** *Empty,* 4,620 (4,541) *lb.; loaded,* 5,734 (5,750) *lb.; maximum permissible,* 6,010 (6,662) *lb.* **Dimensions:** *Span* 37 *ft.* 4 *in.; length,* 28 *ft.* 6 *in.* (28 *ft.* 7¾ *in.*); *height,* 9 *ft.* 6 *in.; wing area,* 236 *sq. ft.*

CURTISS HAWK 75 — U.S.A.

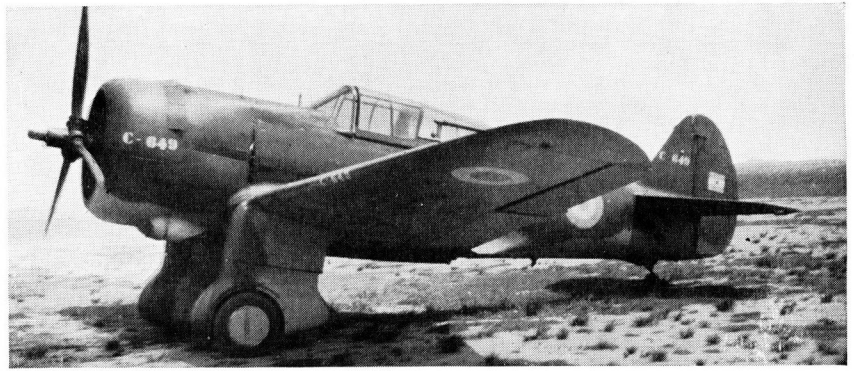
Early in 1937 Curtiss-Wright's Airplane Division began the development of a simplified version of the Y1P-36 interceptor intended specifically for export. Construction was similar to that of the Y1P-36, the aircraft being all-metal with an Alclad stressed-skin semi-monocoque fuselage and fabric-covered control surfaces, but a lower powered engine was installed and fixed, single-strut cantilever type main undercarriage members enclosed in streamlined fairings were provided.

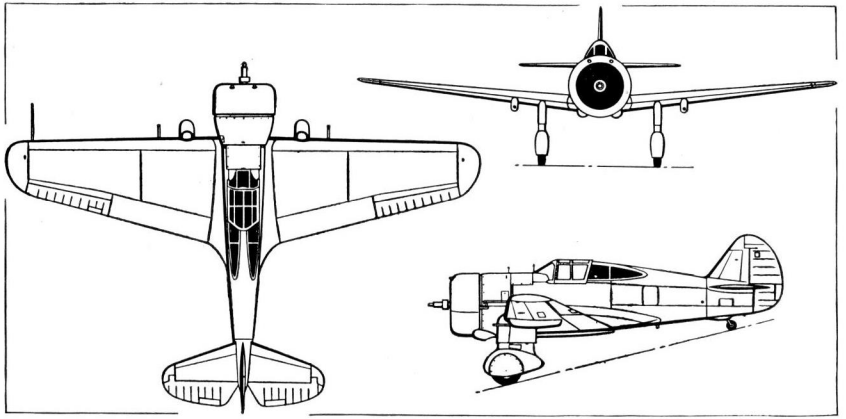
The demonstration model, designated Hawk 75 (the export version with a fully retractable undercarriage later becoming the Hawk 75A), was purchased by the Chinese government in the summer of 1937, and presented by Madame Chiang Kai-shek to General Claire L. Chennault who had been engaged to reorganise the Chinese Air Force, and 112 similar models, designated Hawk 75M, were acquired by China in 1938. These fighters achieved few successes against the Japanese forces, largely owing to the inadequate training of their pilots.

The Royal Thai Air Force received twenty-five similar aircraft designated Hawk 75N in 1939–40, these differing from the Chinese machines in having two additional 0.3-in.



(*Below*) *A Hawk* 75-0 *built in the Argentine and* (*above*) *the demonstration model presented to General Chennault.*





machine guns mounted under the wings, outboard of the main undercarriage members. The Thai Hawk 75N fighters were first in action during the Thai invasion of Indo-China in January 1941, the first recorded combat taking place on the 11th of that month when four fighters of this type, each carrying ten 33-lb. fragmentation bombs, escorted nine Martin 139-W bombers in an attack on the French airfield at Nakorn Wat, destroying several Farman 221s on the ground and shooting down two Morane-Saulnier M.S.406 fighters which attempted to intercept the Thai formation. The Hawk 75Ns were again active on December 7, 1941, during the brief fighting between Thai and Japanese forces.

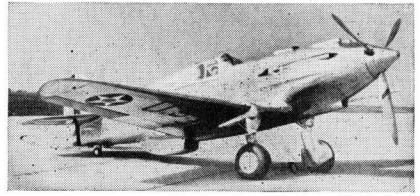
Thirty machines were purchased by the Argentine government as the Hawk 75O together with a manufacturing licence, and the government factory at Cordoba commenced production of the fighter in 1940, subsequently building 200 machines.

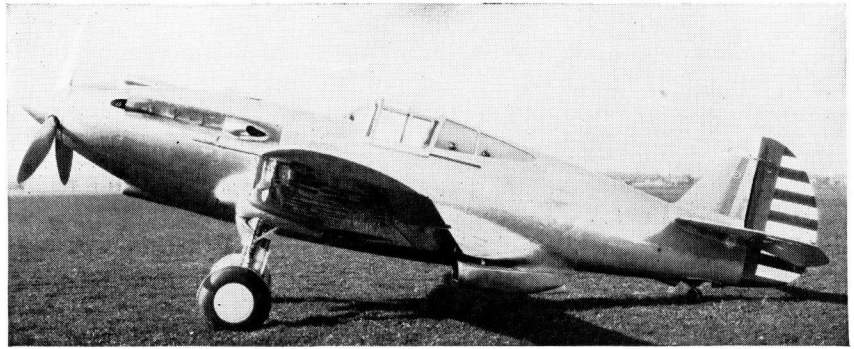
Type: *Single-seat Interceptor and Fighter-bomber.* **Power Plant:** *One* 875 *h.p. Wright GR-1820-G3 nine-cylinder radial air-cooled engine.* **Armament:** *One* 0.3-*in. and one* 0.5-*in. machine gun or one* 0.5-*in. and three* 0.3-*in. machine guns plus ten* 25-*lb. or* 30-*lb. bombs or six* 50-*lb. bombs.* **Performance:** *Maximum speed,* 239 *m.p.h. at sea level,* 280 *m.p.h. at* 10,700 *ft.; range,* 547 *mls. at* 240 *m.p.h. at* 10,700 *ft.; time to* 2,340 *ft.,* 1 *min., to* 22,960 *ft.,* 12.52 *min.; service ceiling,* 31,800 *ft.* **Weights:** *Empty,* 3,975 *lb.; loaded,* 5,172 *lb.; maximum permissible,* 6,418 *lb.* **Dimensions:** *Span,* 37 *ft.* 4 *in.; length,* 28 *ft.* 7 *in.; height,* 9 *ft.* 4 *in.; wing area,* 236 *sq. ft.*

CURTISS P40A–P-40C (TOMAHAWK) U.S.A.

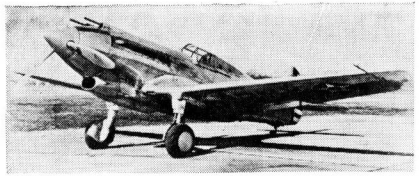
The Curtiss P-40 is undoubtedly destined to remain one of the most controversial Allied fighters of the Second World War. Its performance was invariably inferior to the performances of the fighters by which it was opposed, but it was tractable and capable of absorbing much battle damage. Praised or abused, the P-40 was the only relatively modern fighter available to the U.S.A.A.F. when it went to war, but perhaps the most surprising aspect of its history was the fact that it was retained in production in one form or another until December 1944, long after more advanced types were available in quantity.

The P-40's principal shortcoming was its poor performance at altitude, a direct result of the requirements to which it was produced. These requirements had been formulated at a time when coastal defence and ground attack were expected to be its primary tasks, no possibility of high-altitude enemy attack against the U.S.A. being envisaged. Thus, low-altitude flying qualities and rugged construction were given precedence. The prototype, the XP-40 ordered in July 1937, was actually the tenth production P-36A reworked to incorporate an Allison V-1710-19 (C-13) liquid-cooled engine which offered better

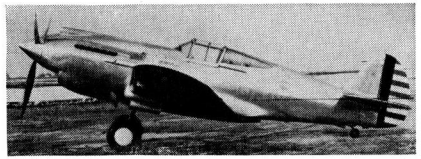




(Below and right) The XP-40 (the tenth P-36A reworked) in the form in which it was originally flown.



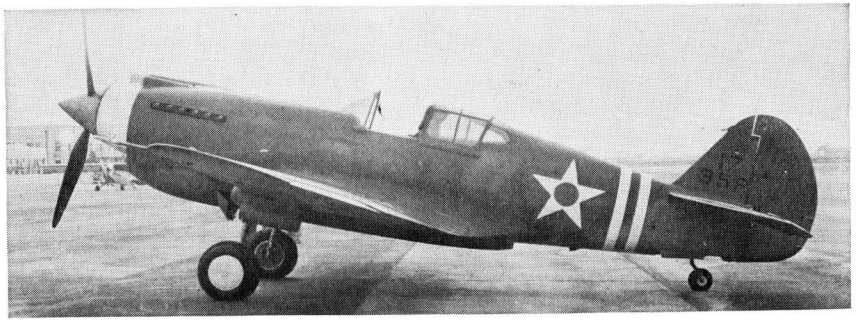
(Above and below) The XP-40 with interim and final radiators.

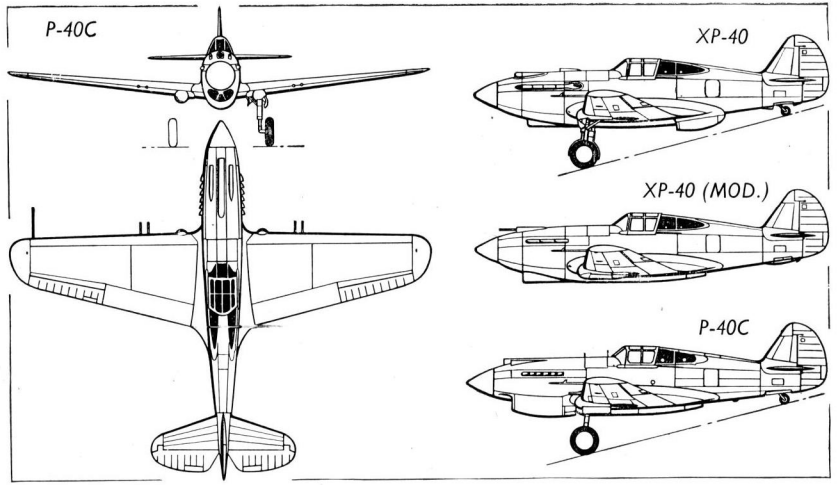


streamlining, more power per unit of frontal area, and better specific fuel consumption than did air-cooled radials of comparable power. The integrally-supercharged engine offered 1,160 h.p. for take-off and 1,000 h.p. at 10,000 ft., and flown for the first time in October 1938, the XP-40 was awarded what was at that time the largest-ever production order for a U.S. fighter on April 27, 1939, calling for the delivery of 524 machines.

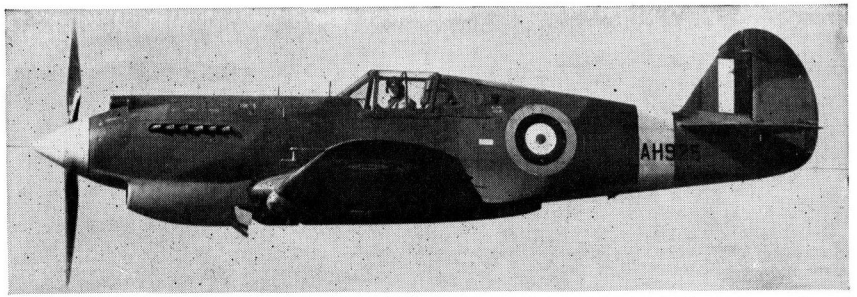
The XP-40 underwent several modifications during its early trials, the principal of which was the removal of the coolant radiator from beneath the rear fuselage to the nose. Armament comprised one 0.3-in. and one 0.5-in. gun in the top nose decking, and performance included a maximum speed of 342 m.p.h. at 12,200 ft., a cruising speed of 299 m.p.h. and a normal range of 460 mls. The first production P-40s appeared in May 1940 and differed from the original XP-40 in several respects. An Allison V-1710-33 (C-15) rated at 1,040 h.p. at 15,000 ft. was installed, an intake for the single-speed supercharger was introduced above the nose, the mainwheel fairing plates were removed, two 0.5-in. guns were mounted in the nose, and flush-headed rivets replaced the brazier-head type to reduce profile drag. The P-40 attained a maximum speed of 357 m.p.h. at 15,000 ft., its initial climb rate was 3,080 ft./min., its range was 950 mls. at 250 m.p.h., and empty and loaded weights were 5,376 lb. and 6,787 lb. respectively.

An early production P-40 of the 35th Pursuit Group. The tail bands indicated the Squadron Commander.





The first three production P-40s were used for service trials, there being no YP-40s, and a further 197 P-40s had been delivered to the A.A.F. by September 1940. However, in April 1940 it had been decided to defer delivery of the remaining 324 P-40s on the original contract in order to expedite urgently needed deliveries of the similar Hawk 81A-1 fighters to France, that country having ordered 140 machines. The P-40 was not really a combat-worthy fighter, lacking armour protection for the pilot, an armour-glass windscreen and self-sealing fuel tanks, but the Hawk 81A-1s, which began to leave the assembly line in September 1940, after France's collapse, were immediately taken over for the R.A.F. The standard synchronized armament of two 0.5-in. guns in the nose top decking was retained, and many of the 140 machines still bore French instrumentation and cockpit lettering when they reached the United Kingdom. Despite the fact that they possessed little in the way of operational equipment, the likelihood of a German invasion necessitated their issue to Nos. 2, 13, 26, 94,



A Tomahawk IIA (*Hawk* 81*A*-2), *one hundred and ten examples of which were supplied to the R.A.F.*

112, 171, 239, 250, 268, 400, 403 and 414 squadrons as the Tomahawk Mks. I, IA, and IB, although, in the event, they were used primarily for training.

One hundred and ten Hawk 81A-2s, or Tomahawk IIAs, followed, these carrying a pair of 0.303-in. Browning machine guns in the wings, some armour protection and self-sealing tanks, and were generally similar to the A.A.F.'s P-40B (the designation "P-40A" not being assigned), 131 examples of which began to reach U.S. squadrons in February 1941. Carrying two 0.5-in. fuselage guns and two 0.3-in. wing guns, the P-40B had a slightly inferior performance to the original production P-40 due to the weight increases brought about by the operational equipment and increased armament. Improved self-sealing fuel tanks, revised internal equipment and a further pair of wing-mounted 0.3-in. guns resulted in a further increase in gross weight and a further reduction in maximum speed in the P-40C, 193 examples of which completed the original Air Corps order, and a further 930 similar machines were built as the Hawk 81A-3 for the R.A.F., entering service as the Tomahawk IIB. The Tomahawk IIB carried an armament of six 0.303-in. machine guns, and whereas the Tomahawk IIA had British radio, the IIB had U.S. equipment. The Tomahawk IIs were shipped to both the U.K. and to Takoradi, West Africa, and operated with Nos. 2, 26, 73, 112, 136, 168, 239, 241, 250, 403, 414, 430 and 616 Squadrons of the R.A.F. They also entered service with Nos. 2 and 4 Squadrons of the South African Air Force and No. 3 Squadron of the Royal Australian Air Force.

From October 1941, the Tomahawk IIs were active in the Middle East, sharing in the strafing of the retreating Axis troops, but the R.A.F. did not take delivery of all 930 Hawk 81A-3s for 100 were relinquished in favour of urgent Chinese requirements, and the last forty-nine machines were shipped direct to the U.S.S.R. Several hundred aircraft were held at maintenance units in the United Kingdom, but when the German invasion failed to materialise 146 were reshipped to the U.S.S.R., while

others were supplied to the Turkish Air Force in 1942. Ninety of the hundred Hawk 81A-3s relinquished in favour of the Chinese reached the American Volunteer Group which began operations from Kunming and Mingaladon in December 1941, their task being the protection of the Burma Road and areas of the Sino-Burmese border. The A.V.G. drew first blood on December 20, 1941 when six out of ten Japanese bombers attacking Kunming were destroyed. Thirteen days earlier, however, A.A.F. fighters of this type had not fared so well at Pearl Harbour. Sixty-two P-40Bs and eleven P-40Cs were based in Hawaii on December 7, 1941, and the majority of these were destroyed on the ground, although a few survived to participate in the initial retaliation sorties, scoring some of the first A.A.F. "kills" of the Pacific War.

A few P-40s were converted as RP-40 reconnaissance fighters in 1941, and one machine was employed by the Pratt and Whitney Aircraft Division of the United Aircraft Corporation as a test-bed for the 1,200 h.p. R-1830 Twin Wasp fourteen-cylinder two-row air-cooled radial housed in a specially-designed close cowling with which it was found to better the performance of standard Allison-powered models.

The following specification relates to the P-40B, figures in parentheses relating to the P-40C.

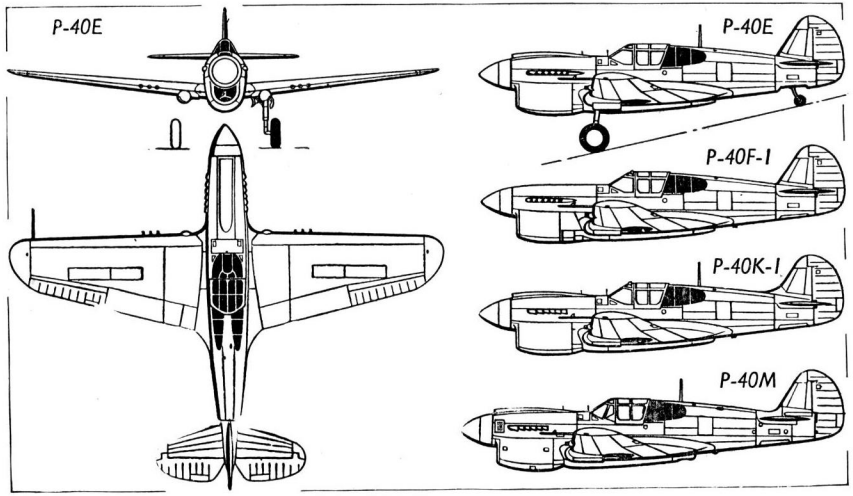
Type: *Single-seat Low- and Medium-altitude Fighter.* **Power Plant:** *One* 1,150 *h.p. Allison V*-1710-33 *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Two* 0.5-*in. machine guns and two* (*four*) 0.3-*in. machine guns.* **Performance:** *Maximum speed,* 352 (345) *m.p.h. at* 15,000 *ft.; cruising speed,* 278 (270) *m.p.h.; normal range,* 730 *mls.; maximum range,* 945 *mls.; initial climb rate,* 2,860 (2,690) *ft./min.; climb to* 15,000 *ft.* 5.1 *min.; service ceiling,* 32,400 (29,500) *ft.* **Weights:** *Empty,* 5,590 (5,812) *lb.; loaded,* 7,325 (7,549) *lb.; maximum,* 7,600 (8,058) *lb.* **Dimensions:** *Span,* 37 *ft.* 3½ *in.; length,* 31 *ft.* 8½ *in.; height,* 10 *ft.* 7 *in.; wing area,* 236 *sq. ft.*

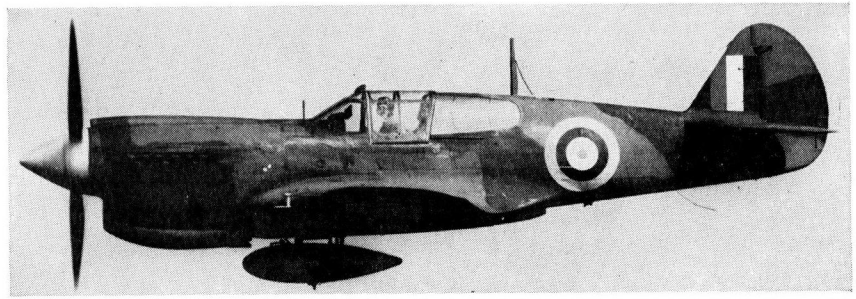
A Tomahawk IIB (*Hawk* 81*A*-3) *of a batch supplied to the Turkish Air Force in* 1942.

CURTISS P-40D–P-40M WARHAWK — U.S.A.

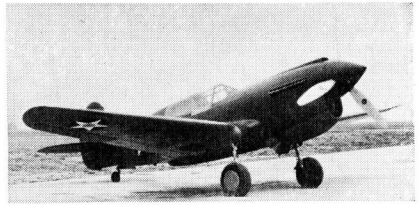
Early in 1940, the availability of the Allison V-1710-39 (F3R) engine rated at 1,150 h.p. for take-off and possessing a similar military rating at 11,700 ft. prompted Curtiss to undertake a redesign of the basic Hawk 81A fighter to take the improved power plant. The external spur airscrew reduction gear of the -39 engine shortened the unit and raised the thrust line, enabling the overall length to be reduced by six inches, the cross-section of the fuselage reduced and the undercarriage shortened. The radiator was enlarged and moved forward, some 175 lb. of armour were incorporated, fuselage guns were omitted in favour of four 0.5-in. wing guns with new hydraulic chargers, and provision was made for a 500-lb. bomb or drop tank.

Designated Hawk 87A-1, the modified fighter had already received a British contract in May 1940, 560 having been ordered as the Kittyhawk I. The first Kittyhawk I was flown on May 22, 1941, by which time the fighter had also been ordered for the U.S. Army as the P-40D, the first production contract having been placed in September 1940. After the delivery of the first twenty





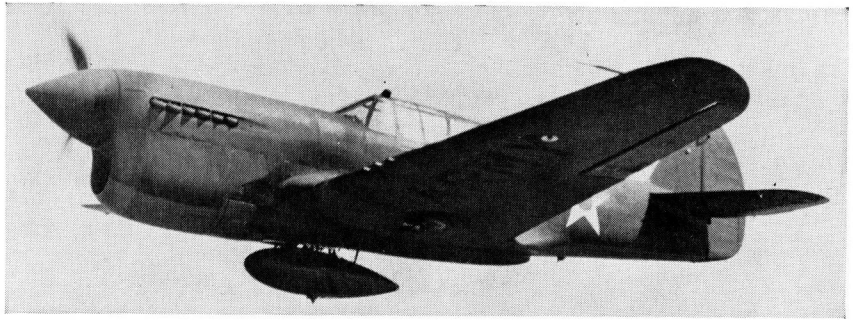
(Above) A Kittyhawk I (Hawk 87A-2) and (right) an early production P-40D Warhawk.

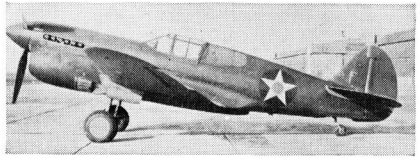


Kittyhawk Is, the wing-mounted armament was increased to six 0.5-in. guns with 281 r.p.g. (Hawk 87A-2). Only twenty-two P-40Ds were produced with four wing guns, an order dated February 18, 1941, having increased the armament to six guns, subsequent aircraft with this armament being designated P-40E. Additional orders placed in February, May and June 1941 raised total production of the P-40E to 2,320 aircraft (820 P-40Es and 1,500 P-40E-1s, the latter embodying minor modifications). The P-40E-1s (Hawk 87A-3s) were purchased with Lend-Lease funds for Britain, these being known as Kittyhawk IAs to distinguish their Lend-Lease origin, and twelve of these were sent to Canada in March 1942, while many others were shipped direct to Australia for the R.A.A.F.

Kittyhawk Is and IAs (P-40E-1s) became operational with the R.A.F. in the Western Desert in 1942, being used primarily at low altitudes and for close support. The climb rate and ceiling of the fighter were relatively poor but, fitted with bomb racks beneath the wings from June 1942, the Kittyhawk wrought much havoc among Rommel's armour. Some thirty P-40Es were supplied to the American Volunteer Group fighting the Japanese, and a few P-40Es were converted as two-seat trainers by replacing the fuselage fuel tank with a second seat.

In an attempt to improve the fighter's altitude performance, a British-built Rolls-Royce Merlin 28 engine with a single-stage, two-speed supercharger was installed in a P-40D airframe and flown for the first time as the XP-40F on November 25, 1941. The production model had a Packard-built V-1650-1 Merlin rated at 1,300





(*Left*) *The XP-40F and* (*above*) *a P-40F-1-CU.*

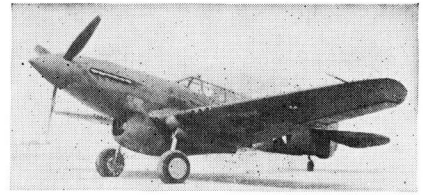
h.p. for take-off and 1,120 h.p. at 18,500 ft. Like the prototype, the production P-40F had the intake above the cowling which characterised Allison-powered models incorporated in the radiator scoop, although the YP-40F (the third production P-40F) was experimentally flown with a deep ventral radiator moved aft. A total of 1,311 P-40F Warhawks were built in 1942, the P-40F-1-CU having the same 31 ft. 2 in. fuselage as the E-model, but subsequent machines having an overall length of 33 ft. 4 in., the fin and rudder being moved rearward of the tailplane in order to improve directional stability. Of the total production, 250 P-40F Warhawks were purchased with Lend-Lease funds, and the type was designated Kittyhawk II by the R.A.F. In the event, the R.A.F. did not receive any of this model as 100 were transferred to the Soviet Union, some were lost at sea, others went to the Free French and the remainder were retained by the A.A.F.

The sixty-sixth production P-40 had, prior to the introduction of the Warhawk series, been modified to carry six 0.5-in. wing guns, operational armour and self-sealing tanks, becoming the sole XP-40G. The designation P-40H was not assigned, and the P-40J was a 1942 project to boost the altitude performance of the Allison engine by the addition of a turbo-supercharger.

Despite the introduction of the Merlin engine in the Warhawk, parallel production of the Allison-powered version continued owing to the limited supplies of the licence-built British engine, and the P-40K marked the introduction of the more powerful Allison V-1710-73 (F4R) engine rated at 1,325 h.p. for take-off and 1,150 h.p. at 11,800 ft. Six hundred

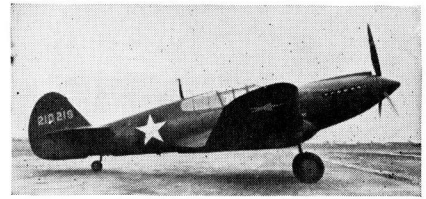
P-40K Warhawks had been ordered on October 28, 1941 for Lend-Lease supply to China (although, in the event, China received only 377 Warhawks of all types under Lend-Lease), it being envisaged that this would be the last P-40 model to be manufactured in quantity, but a total of 1,300 P-40K Warhawks was eventually to be built, this model appearing in August 1942, and subsequently serving with the A.A.F. and the R.C.A.F., particularly in Alaska and the Aleutians. Twenty-one also reached the R.A.F. as the Kittyhawk III. The initial production P-40K-1 to K-5 batches retained the short fuselage of the P-40E, but with the extra power there was a tendency to swing during take-off, and a dorsal fin was added to correct this fault, while the P-40K-10 to K-15 production batches embodied the lengthened fuselage introduced on the P-40F. The P-40K also introduced automatic boost control. One P-40K-10-CU was modified as the XP-40K with radiators in a swollen wing centre section and a slim, pointed nose.

In a further attempt to improve the Warhawk's performance for short-range combat, the P-40L was a partially stripped version of the P-40F in which 250-lb. in weight was saved. Internal fuel was reduced by 31 Imp. gal. and armament was restricted to four 0.5-in. guns with 201 r.p.g. in all production batches subsequent to the P-40L-1-CU (which had the same fuel and armament as the P-40F). Some armour was removed, and 700 P-40L Warhawks were manufactured in 1943 when scarcity of Merlin engines necessitated concentration on the production of Allison-powered models. Despite the weight saving, the P-40L's maximum speed was a mere 4 m.p.h. greater than that of the P-40F at rated altitude. Three hundred P-40F and P-40L Warhawks were re-engined with Allison V-1710-81s as P-40Rs when their original power plants needed replacement.

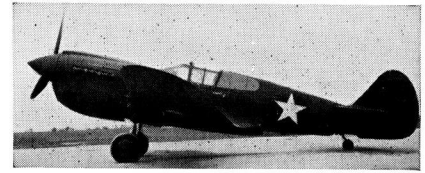


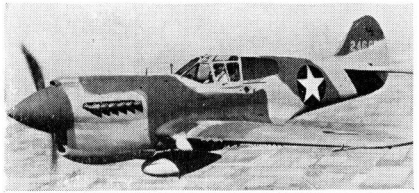
The YP-40F (*originally third P-40F-1-CU*).

The P-40M was essentially similar to the P-40L apart from the use of the Allison V-1710-81 engine rated at 1,200 h.p. for take-off and 1,125 h.p. at 17,300 ft. The P-40M was built solely for Lend-Lease supply to Britain, and 595 were delivered to the R.A.F., the R.A.A.F., and the R.N.Z.A.F. of the 600

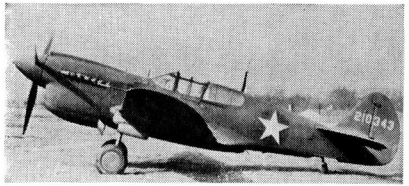


(*Above*) *The XP-40K and* (*below*) *first P-40K-1-CU.*

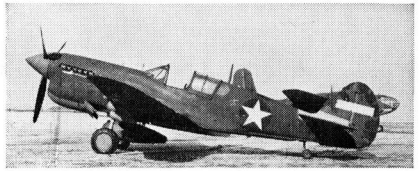




(*Above*) *A standard P-40K-1-CU Warhawk.*



(*Above*) *P-40K-15-CU and* (*below*) *P-40L-5-CU.*



produced. Like the P-40K, these were known as Kittyhawk IIIs, and while some went to squadrons in the Middle East, the majority were shipped to the Far East. The Kittyhawk III also equipped No. 5 Squadron of the S.A.A.F. in Italy.

The following specification relates to the P-40E, figures in parentheses referring specifically to the P-40K.

Type: *Single-seat Fighter-bomber.* **Power Plant:** *One* 1,150 (1,325) *h.p.* Allison *V*-1710-39 (-73) *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Six* 0.5-*in. machine guns with* 281 *r.p.g. plus one* 500-*lb. and two* 100-*lb. bombs.* **Performance:** *Maximum speed,* 335 (320) *m.p.h. at* 5,000 *ft.,* 345 (343) *m.p.h. at* 10,000 *ft.,* 362 (363) *m.p.h. at* 15,000 *ft.; climb rate,* 2,100 (2,160) *ft./min. at* 5,000 *ft.,* 1,450 (1,650) *ft./min. at* 15,000 *ft.; time to* 10,000 *ft.,* 4.8 (4.9) *min., to* 20,000 *ft.,* 11.5 (11.2) *min.; service ceiling,* 29,000 (28,000 *ft.; maximum range* (*clean*), 650 (700) *mls. at* 10,000 *ft.,* (*with one* 43 *Imp. gal. drop tank*), 850 (900) *mls.,* (*with one* 141.5 *Imp. gal. drop tank*), (1,400) *mls, at* 10,000 *ft.* **Weights:** *Empty,* 6,350 (6,400) *lb.; normal loaded,* 8,280 (8,400) *lb.; maximum,* 9,200 (10,000) *lb.* **Dimensions:** *Span,* 37 *ft.* 4 *in.; length,* 31 *ft.* 2 *in.* (33 *ft.* 4 *in.*)*; height,* 10 *ft.* 7 *in.; wing area,* 236 *sq. ft.*

The following specification relates to the P-40F Warhawk.

Type: *Single-seat Fighter-bomber.* **Power Plant:** *One* 1,300 *h.p. Packard Rolls-Royce Merlin V*-1650-1 *twelve cylinder Vee liquid-cooled engine.* **Armament:** *Six* 0.5-*in. machine guns with* 281 *r.p.g., plus one* 500-*lb. and two* 100-*lb. bombs.* **Performance:** *Maximum speed,* 320 *m.p.h. at* 5,000 *ft.,* 340 *m.p.h. at* 10,000 *ft.,* 352 *m.p.h. at* 15,000 *ft.,* 364 *m.p.h. at* 20,000 *ft.; time to* 10,000 *ft.,* 4.5 *min., to* 20,000 *ft.,* 11.6 *min.; maximum range,* 700 *mls. at* 10,000 *ft.,* (*with one* 43 *Imp. gal. drop tank*), 875 *mls.,* (*with one* 141.5 *Imp. gal. drop tank*), 1,500 *mls.; service ceiling,* 34,400 *ft.* **Weights:** *Empty,* 6,590 *lb.; normal loaded,* 8,500 *lb.; maximum,* 9,350 *lb.* **Dimensions:** *Span,* 37 *ft.* 4 *in.; length,* 33 *ft.* 4 *in.; height,* 10 *ft.* 7 *in.; wing area* 236 *sq. ft.*

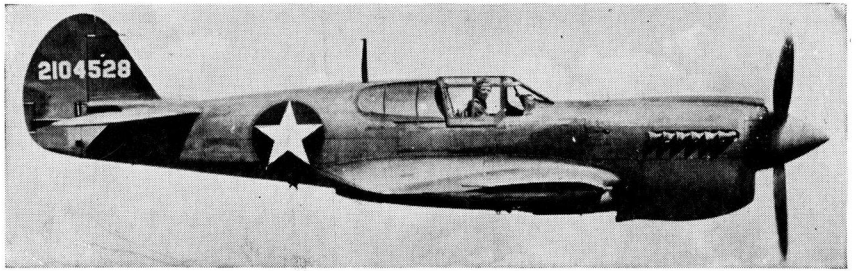
CURTISS P-40N–P-40Q WARHAWK — U.S.A.

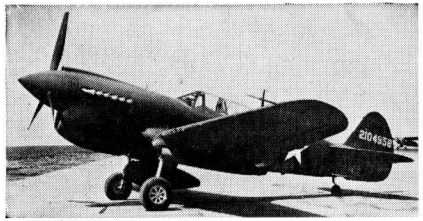
By the beginning of 1944, the performance of the P-40 Warhawk was leaving much to be desired, and in a determined effort to improve the capabilities of the basic design and thus avoid interrupting production by introducing an entirely new type, a new lightweight structure was evolved for the P-40N which appeared in March 1944. Two of the six wing guns were originally removed, together with the front wing tank, and aluminium oil coolers and radiators were incorporated, as well as lighter wheels, reducing empty weight to 6,000 lb. The first 400 Warhawks of the P-40N-1-CU production batch were the fastest examples of the basic design to be built, attaining 378 m.p.h. at 10,500 ft.

With the P-40N-5-CU production batch the full six-gun armament was restored, and all 1,977 P-40N Warhawks up to and including the P-40N-15-CU batch had the M-model's high-rated Allison V-1710-81, but the 3,022 Warhawks in the P-40N-20 to -35 batches had the V-1710-99 of similar rating, and the 220 P-40N-40-CU Warhawks completed had the V-1710-115. The P-40N-5-CU and subsequent batches introduced a modified cockpit canopy with a frameless sliding hood and a deeper, rectangular aft section to improve rearward view, and external stores capacity increased to 1,500 lb. Improved non-metallic self-sealing fuel tanks, new radio and oxygen equipment, and flame-damping exhausts were progressively introduced.

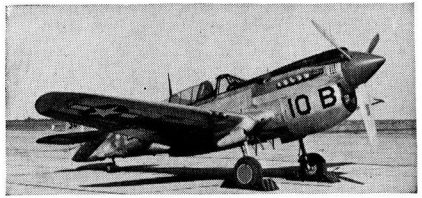
A total of 586 P-40N Warhawks were supplied to Great Britain under Lend-Lease as the Kittyhawk IV, these equipping R.A.F. units in Italy, including Nos. 250 and 450 Squadrons, but most were employed in the Far East by the R.A.F., the R.A.A.F., and the R.N.Z.A.F. A large proportion of the 2,097 P-40s supplied to the Soviet Union were of the N-model, but they were not very popular with the Russians who considered them incapable of absorbing as much battle damage as the P-39 Airacobra. The last production Warhawk was a P-40N-40-CU which left the assembly

The P-40N-1-CU Warhawk was the fastest example of the basic design to be built.

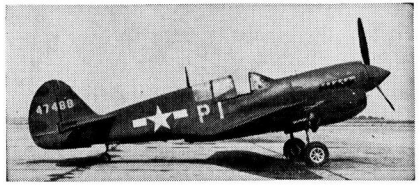




The P-40N-5-CU with full six-gun armament.



One of the last Warhawks, the P-40N-25-CU.



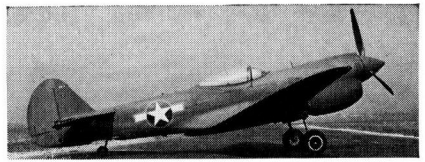
The P-40N-35-CU had the V-1710-99 engine.

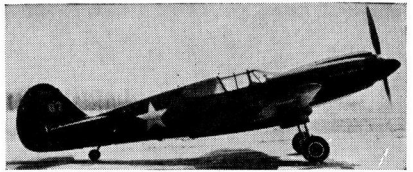
line in December 1944, being the 13,738th P-40 built.

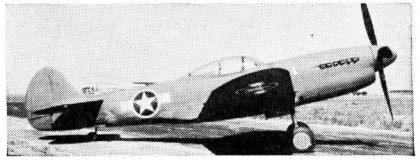
Prior to the final termination of Warhawk development, a general modernization programme was undertaken with a single P-40K airframe. Redesignated XP-40Q, this aircraft was fitted with an Allison V-1710-121 engine rated at 1,425 h.p. for take-off and driving a four-blade airscrew. Originally flown with leading-edge radiators in the wing centre section, it was progressively modified, and in its second configuration the radiator was brought forward beneath the nose, a free-blown "bubble" canopy was fitted and the rear fuselage cut-down. In its third and final configuration, the XP-40Q's wing span was reduced to 35 ft. 3 in. as compared with an overall length of 35 ft. 4 in. The engine was fitted with water injection and, possessing a maximum weight of 9,000 lb., the XP-40Q attained 422 m.p.h. at 20,500 ft., climbed to an altitude of 20,000 ft. in 4.8 minutes and possessed a service ceiling of 39,000 ft. Four 0.5-in. wing guns were carried by the prototype but proposed production models were to have carried either six 0.5-in. or four 20-mm. guns, but the XP-40Q was still inferior to contemporary production Mustangs and Thunderbolts, and development was therefore abandoned.

The following specification relates to the P-40N-15-CU.

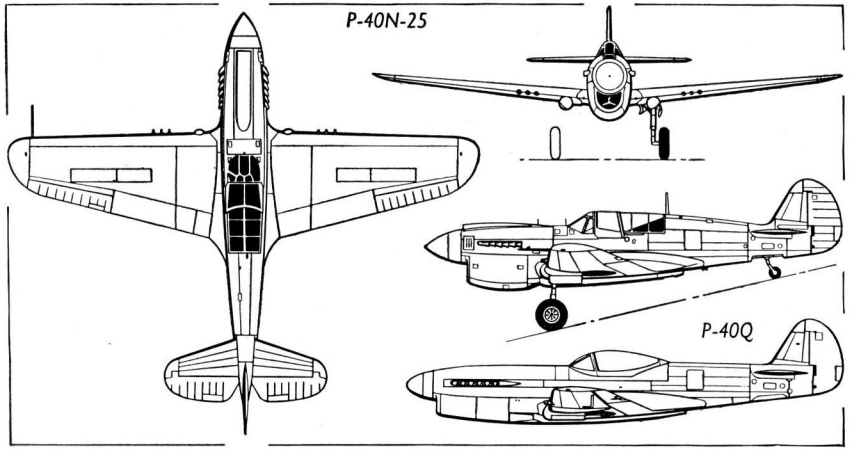
Type: *Single-seat Fighter-bomber.* **Power Plant:** *One* 1,200 *h.p. Allison V-*1710-81 *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Six* 0.5-*in. machine guns with* 281 *r.p.g. plus three* 500-*lb. bombs.* **Performance:** *Maximum speed,* 308 *m.p.h. at* 5,000 *ft.,* 325 *m.p.h. at* 10,000 *ft.,* 343 *m.p.h. at* 15,000 *ft.; maximum climb rate,* 2,120 *ft./min. at* 5,000 *ft.,* 2,230 *ft./min. at* 10,000 *ft.; time to* 10,000 *ft.,* 4.7 *min., to* 20,000 *ft.,* 8.8 *min.; service ceiling,* 31,000 *ft.; range,* 750 *mls. at* 10,000 *ft.,* (*with one* 62.4 *Imp. gal. drop tank*), 1,080 *mls.* **Weights:** *Empty,* 6,200 *lb.; loaded,* 8,350 *lb.; maximum,* 11,400 *lb.* **Dimensions:** *Span,* 37 *ft.* 4 *in.; length,* 33 *ft.* 4 *in., height,* 10 *ft.* 7 *in.; wing area,* 236 *sq. ft.*







(Above) One airframe featured a cut-down rear fuselage and all-round-vision "bubble" canopy as the XP-40N. (Above, right) The XP-40Q in its original form with leading-edge radiators in the wing centre section, and (right) the XP-40Q in its second configuration with the radiator brought forward beneath the nose and a "bubble" canopy. The wing span was later reduced and the wingtips clipped.

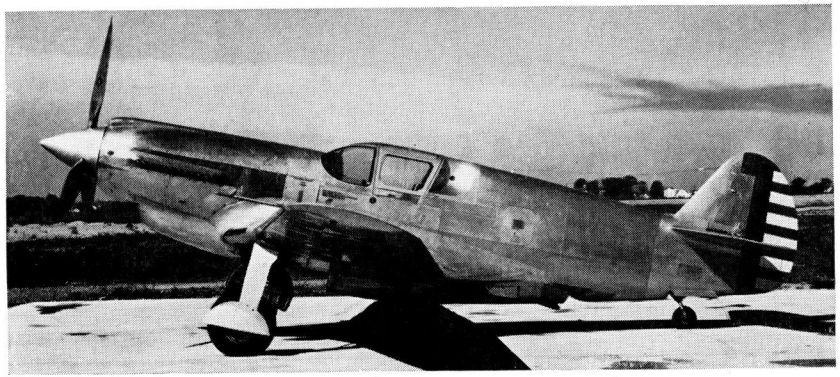


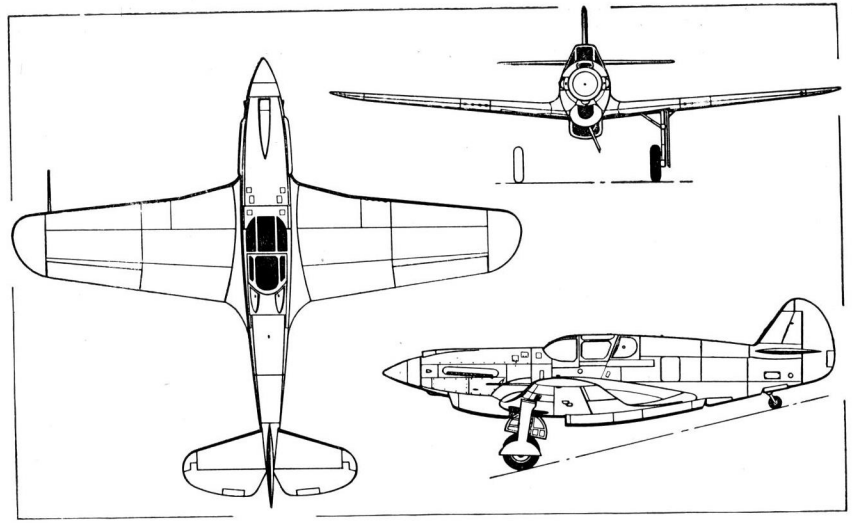
CURTISS XP-46 U.S.A.

By the summer of 1939, U.S. fighter designers were being increasingly influenced by developments in Europe, and Curtiss attempted to combine some of what they considered to be the best features of the latest European fighters in a potential successor to the P-40 which, at that time, was entering quantity production. An Army Air Corps specification was drawn up around Curtiss's proposals, and prototypes were ordered on September 29, 1939 as the XP-46.

The newly-developed Allison V-1710-39 (F3R) engine rated at 1,150 h.p. for take-off was specified for the fighter, and a maximum speed of 410 m.p.h. was somewhat optimistically called for at 15,000 ft. The new fighter was smaller than the P-40, and featured a wide-track, inward-retracting undercarriage, and in view of the relatively high wing loading, automatic leading-edge slots such as had been introduced successfully by the Messerschmitt Bf 109 were fitted to give increased aileron control near the stall. Ideas on armament were influenced by Britain's Hurricane and Spitfire, for, in addition to the standard pair of synchronised 0.5-in. guns in the forward fuselage decking, provision was made in the design for a battery of eight wing-mounted 0.3-in. guns. A month after the prototypes had been ordered, the Army Air Corps modified their requirements, calling for the inclusion of self-sealing fuel tanks and 65 lb. of armour protection for the pilot. The resulting increase in weight was expected to have an adverse effect on performance which, in the event, was to prove singularly disappointing.

The XP-46 (below) was one of two prototypes of a small fighter the design of which owed much to European combat experience.





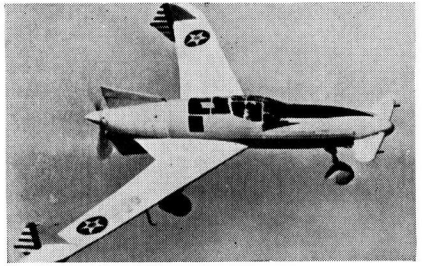
Two prototypes of the XP-46 were completed, the second machine, which was in fact the first to fly on February 15, 1941, carrying no armament and being designated XP-46A. While the prototypes had been under construction, however, the decision had been taken to replace the XP-46 in the Army Air Corps' procurement planning with a similarly-powered development of the P-40. This decision, taken in June 1940, had the advantage of avoiding the disruption of the Curtiss production lines by the introduction of an entirely new airframe at a critical period, and, in the event, the XP-46's performance under test proved to be inferior to that of the V-1710-39-powered P-40D.

Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 1,150 *h.p. Allison V-*1710-39 *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Two* 0.5-*in. and eight* 0.3-*in. machine guns.* **Performance:** *Maximum speed,* 355 *m.p.h. at* 12,200 *ft.; maximum cruising speed,* 332 *m.p.h.; time to* 12,300 *ft.,* 5 *min.; service ceiling,* 29,500 *ft.; range at maximum cruising speed,* 325 *mls.* **Weights:** *Empty,* 5,625 *lb.; loaded,* 7,322 *lb.; maximum,* 7,665 *lb.* **Dimensions:** *Span,* 34 *ft.* 4 *in.; length,* 30 *ft.* 2 *in.; height,* 13 *ft.* 0 *in.; wing area,* 208 *sq. ft.*

CURTISS XP-55 ASCENDER

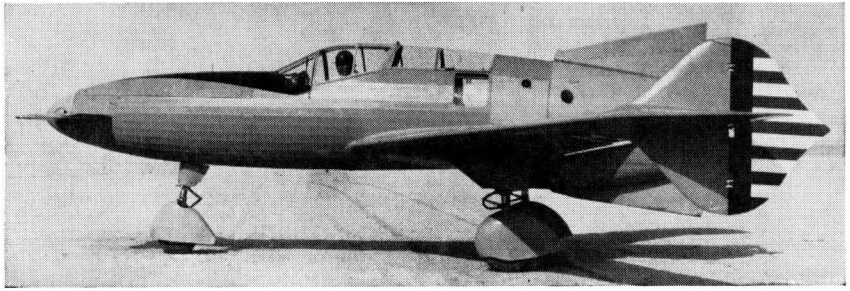
U.S.A.

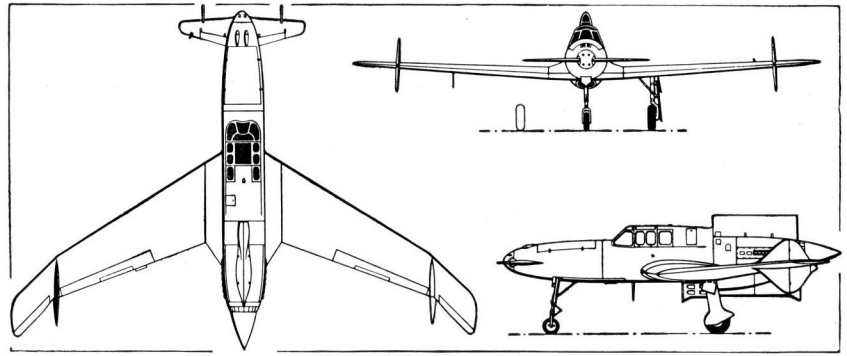
One of the most radical fighter designs to fly during the Second World War, the Curtiss Model 24 Ascender, or XP-55, was evolved as a result of Circular Proposal R-40C which called for a fighter powered by the Pratt and Whitney X-1800-A3G engine which, by employing unconventional design, offered enhanced pilot visibility and armament installation, and a considerable reduction in overall drag by comparison with similarly powered single-seaters of conventional configuration. An Air Corps specification issued on November 27, 1939 set forth performance requirements and, in addition to Curtiss-Wright, the Vultee and Northrop companies submitted design proposals, these eventually appearing as the XP-54 and XP-56 and also employing unorthodox configurations. The Curtiss-Wright design was placed second in the competition.



Unlike the Italian S.A.I. S.S.4 (page 186, Volume II) or the Japanese Kyushu J7W1 Shinden (page 38, Volume III), the XP-55 was not a true "canard" in that it had no fixed forward surface. It was essentially a flying wing with a controllable nose-mounted elevator. On June 22, 1940, Curtiss-Wright received a contract calling for preliminary engineering data and a powered wind tunnel model, but as the Air Corps was not entirely satisfied with the results of the wind tunnel tests, Curtiss-Wright financed the construction

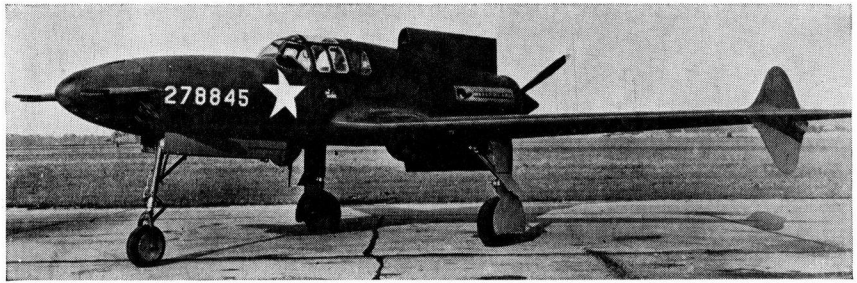
(Left and below) The Model 24-B, a flying full-scale model of the XP-55 Ascender fighter.



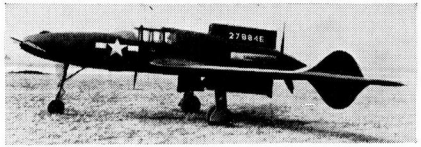


of a flying full-scale model. Designated Model 24-B, this research machine was powered by a 275 h.p. Menasco C68-5 engine and comprised a fabric-covered, welded steel-tube fuselage and a wooden wing. The undercarriage was fixed. The Model 24-B was tested at Muroc, early flights indicating a certain amount of directional instability. Various types of auxiliary wingtip fins were fitted, these improving directional stability. A further improvement was obtained by adding vertical fins to the top and bottom of the engine cowling. A total of 169 flights with the Model 24-B were made at Muroc between November 1941 and May 1942, and on July 10, 1942, a contract was issued for three XP-55 fighters powered by the Allison V-1710 (F16), which engine was selected in preference to the X-1800 on the basis of reliability and availability, and carrying an armament of two 20-mm. cannon and two 0.5-in. machine guns. Mock-up inspections resulted in several changes, the most important being a reduction in fuel capacity, a switch to the Allison V-1710-95 engine, and the replacement of the 20-mm. cannon by 0.5-in. guns.

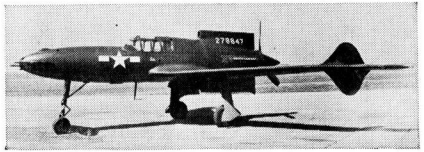
The first XP-55 was completed on July 13, 1943, and flight testing began immediately. Excessive take-off run resulted in a fifteen per cent increase in nose elevator area, and the aileron up trim was interconnected with the flaps so that it operated when these were lowered. This aircraft was destroyed on November 15, 1943 during stall tests when the XP-55 flicked onto its back and stabilized in a vertical, inverted descent, engine failure rendering recovery impossible. Subsequent investigation revealed the fact that stall characteristics could be improved by the addition of wingtip extensions of greater area and increasing the limits of nose elevator travel. These modifications were incorporated in the third XP-55 which was still under construction, the second XP-55 having flown on January 9, 1944. All flight tests with this aircraft were restricted to clear the stall zone until the third XP-55 had



The first prototype XP-55 Ascender which was first flown on July 13, 1943 and crashed four months later.



(*Above*) *The second and* (*below*) *the third XP-55s.*



been satisfactorily stall tested, the latter machine flying for the first time on April 25, 1944.

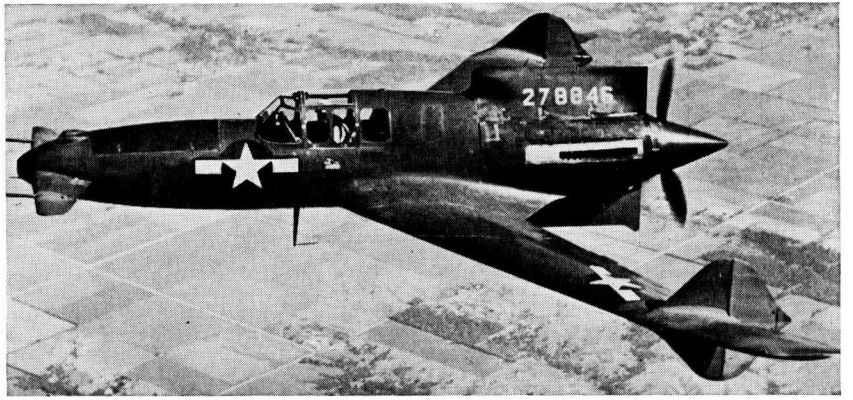
The second XP-55 was essentially similar to the first aircraft apart from a slightly larger nose elevator, a modified elevator tab system, and a change from balance tabs to spring tabs on the ailerons. The third XP-55 incorporated the extended wingtips with so-called "trailerons", and the increased elevator travel limits. However, the first flight revealed that the increased elevator limits resulted in the pilot being able to hold such a high elevator angle during the take-off run that the elevator stalled. After modifications, stall tests were satisfactorily undertaken, although the complete lack of warning prior to the stall and the excessive loss of altitude necessary to return to level flight were undesirable characteristics. An artificial stall warning device was introduced, and between September 16 and October 2, 1944, the second XP-55, which had been modified to the same standards as the third aircraft, underwent official A.A.F. performance trials. The results of these trials indicated that, in general, the handling characteristics of the XP-55 were satisfactory during level flight and climb tests, but at low speeds and during landings there was a disconcerting tendency to over-control on the elevators due

to lack of "feel". Stall behaviour was both unconventional and undesirable, stall warning being insufficient and recovery involving an excessive loss of altitude. A serious handicap was engine cooling which was critical during all phases of operation. Flown at a take-off gross weight of 7,929 lb., the XP-55 attained a maximum speed of 377.5 m.p.h. at 16,900 ft. during these trials, but the official conclusions were that the performance did not compare favourably with standard production fighters, being below that guaranteed by the manufacturers, and that it was not desirable as a combat aircraft at that stage in its development.

As a result of these and subsequent tests, it was apparent that the advantages of the XP-55 over the conventional fighter did not justify the unorthodox configuration with its inherently bad stalling characteristics and questionable stability, and further development was abandoned.

Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 1,275 *h.p. Allison V*-1710-95 (*F23R*) *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Four* 0.5-*in. Colt-Browning M*2 *machine guns with* 200 *r.p.g.* **Performance:** *Maximum speed,* 390 *m.p.h. at* 19,300 *ft.,* 377.5 *m.p.h. at* 16,900 *ft.; normal range,* 635 *mls. at* 296 *m.p.h.; maximum range,* 1,440 *mls.; time to* 20,000 *ft.,* 7.1 *min.; service ceiling,* 34,600 *ft.* **Weights:** *Empty* 6,354 *lb.; normal loaded,* 7,330 *lb.; maximum,* 7,929 *lb.* **Dimensions:** *Span,* 44 *ft.* 0½ *in.; length,* 29 *ft.* 7 *in.; height,* 10 *ft.* 0¾ *in.; wing area,* 235 *sq. ft.*

The XP-55 Ascender, the second prototype of which is illustrated below, was not a true "canard" in that it possessed no fixed forward surfaces.



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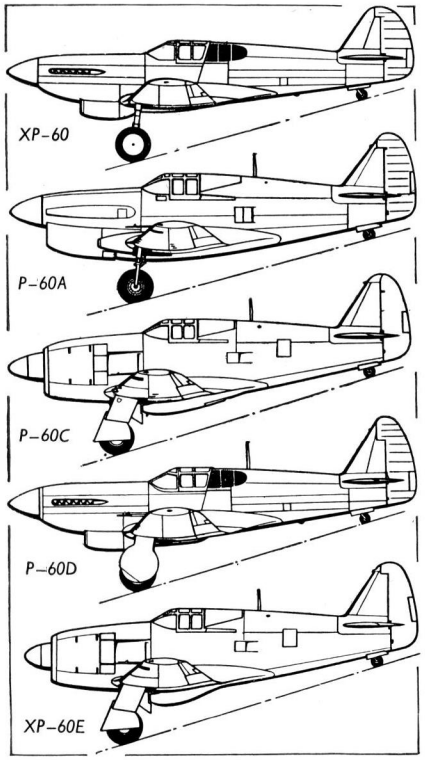
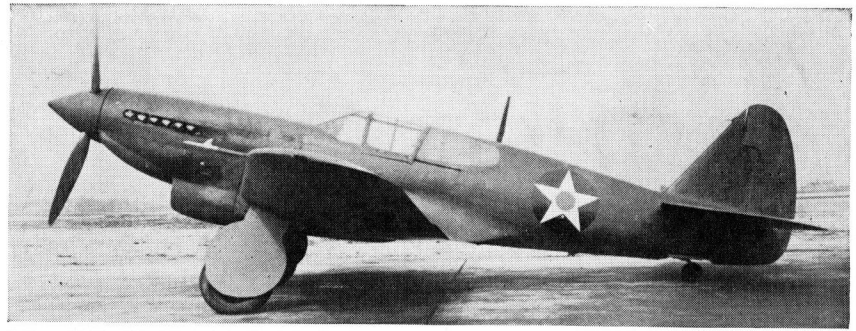


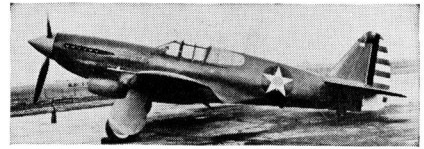
In the early summer of 1940, with the first production P-40s leaving the assembly line, the Curtiss-Wright Corporation was naturally preoccupied with the desire to maintain their position as the leading American manufacturer of fighter aircraft by producing the P-40's successor. Several proposals had been made to the Army Air Corps, the most promising being a development of the basic P-40 design featuring the N.A.C.A.'s low-drag laminar-flow aerofoil, the Continental XIV-1430-3 inverted-vee engine then under development and expected to develop 1,600 h.p. at 15,000 ft., and a wing-mounted armament of eight 0.5-in. guns.

This proposal was accepted by the A.A.C. as the XP-53, and two prototypes were ordered on October 1, 1940. At a conference held six weeks later, however, Curtiss-Wright were informed of the Air Corps' desire to obtain a fighter combining laminar-flow wings with the British Merlin engine, and the decision to complete the second XP-53 with this power plant as the XP-60. Provision was to be made for the alternative installation of the Continental engine, and the P-40-type rearward-retracting undercarriage was to be replaced by a new inward-retracting landing gear. In order to expedite flight testing, the armament installation, self-sealing fuel tanks and pilot armour were to be eliminated. Modifications were held to a minimum and, ten months later, on September 16, 1941, the XP-60 began taxiing trials, flying for the first time two days later with a British-built Merlin 28. In November it was decided to convert the XP-53 prototype into a static test airframe for the production P-60, and install the bullet-proof windscreen, self-sealing fuel tanks and armament (reduced to six 0.5-in. guns) from this aircraft in the XP-60.

The choice of the Merlin engine for other

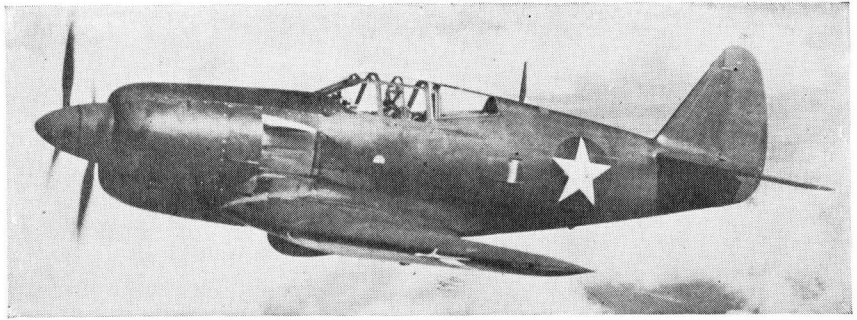


(*Above*) *The XP-60D with the Merlin 61 engine was a conversion of the XP-60* (*right*).

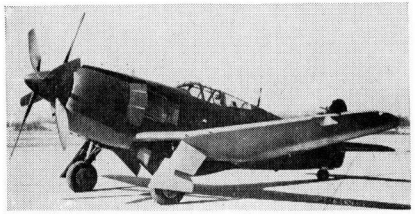


fighters and possible delays in quantity deliveries of the licence-built version of this power plant from Packard had resulted in consideration being given to the installation of a turbo-supercharged Allison V-1710-75 offering 1,425 h.p. at 25,000 ft., and when, on October 31, 1941, a contract for 1,950 P-60A fighters was approved, the Allison engine was selected on the basis of reliability and availability. In the meantime, flight testing of the XP-60 had not been proceeding entirely smoothly, and on two occasions the aircraft had suffered damage as the result of undercarriage failures. The XP-60 had an empty weight of 7,008 lb. and a design gross weight of 9,700 lb., and attained a maximum speed of 380 m.p.h. at 20,000 ft., but performance did not comply with the manufacturer's guarantees due to the wing surface not being finished to the degree of smoothness required for the laminar-flow wing and the fact that the engine did not deliver guaranteed output. On November 17, 1941, it was pointed out that the P-60A would be underpowered and that a more powerful engine should be installed or another fighter built in lieu of the P-60A. Work on the P-60A therefore stopped on December 20th, and on January 2, 1942 it was decided that only one XP-60A, one XP-60B and one XP-60C should be built. The XP-60A was to have the Allison V-1710-75 engine and a General Electric B-14 turbo-supercharger, the XP-60B, was to be similar apart from the installation of a Wright SU-504-2 turbo-supercharger, and the XP-60C was to be fitted with the Chrysler XIV-2220 sixteen-cylinder engine.

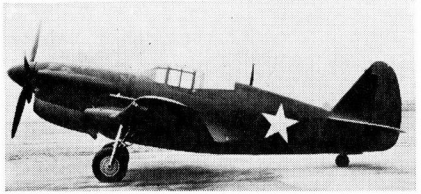
On April 1, 1942 Curtiss-Wright submitted a preliminary study on the installation of the



(*Above and left*) *The XP-60C with an R-2800-53 engine driving contra-rotating airscrews.*



(*Below*) *The XP-60A with the Allison V-1710-75.*

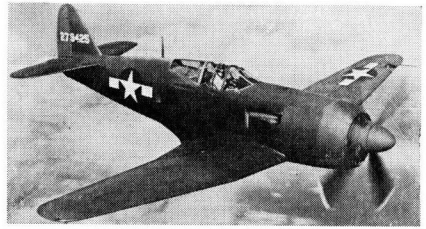


Chrysler engine in the XP-60C which indicated that it would be necessary to install several hundred pounds of lead in the tail of the existing airframe for ballast or design a new fuselage. As the status of the XIV-2220 engine was, at this time, somewhat questionable, a decision was held in abeyance, but in August it was proposed that a Pratt and Whitney R-2800 radial replace the Chrysler engine in the XP-60C and, in the following month, this suggestion was agreed to. In the meantime, the original XP-60 had been returned to Curtiss-Wright for the installation of a Merlin 61 engine. The vertical tail surfaces were enlarged and the aircraft was redesignated XP-60D.

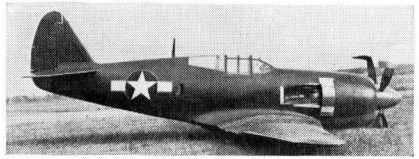
The XP-60A made its initial ground run during the latter part of October 1942, but a minor fire occurred in the engine due to the lack of cooling air in the shrouds surrounding the exhaust manifold. The turbo-supercharger and long exhaust manifold were, therefore, removed and short exhaust stacks fitted, the

first flight being effected on November 1, 1942. Official interest in the P-60 had waned throughout the summer of 1942, but Curtiss-Wright's proposal to install the R-2800 in the XP-60C and the substantial performance improvement that this modification promised aroused such a renewal of interest in the fighter that, in November 1942, a letter contract was prepared to cover the construction of 500 R-2800-powered P-60A-1-CU fighters. However, it appeared unlikely that the contra-rotating airscrews and necessary engine gearing specified by the contract would be available for installation in the first production P-60A-1-CUs, and therefore the XP-60B was modified to take an R-2800-10 engine driving a four-blade airscrew as the XP-60E.

The XP-60C was flown for the first time on January 27, 1943 with an R-2800-53 engine driving contra-rotating airscrews, and apart from somewhat high elevator and rudder forces, the aircraft's characteristics were generally satisfactory. Owing to the lighter airscrew installation of the XP-60E, it was found necessary to move the engine forward ten inches by comparison with that of the XP-60C, and owing to a fault experienced during initial ground running which necessitated an engine change, the first flight did not take place until May 26, 1943. Prior to this event, however, the A.A.F. had decided to undertake comparative tests at Patterson Field with various fighter types in an attempt to eliminate the least desirable and concentrate production on the best types available at that time. During the latter part of April 1943, Curtiss-Wright were notified that the XP-60E would have to be delivered to Patterson Field to participate in these trials within four days. The XP-60E had not then flown, and the request was received only a few days after a piece of engine accessory cowl had been lost in flight from the XP-60C which had subsequently been



(*Above*) *The XP-60E* (42-79425) *in flight and* (*below*) *after the forced landing which terminated testing.*



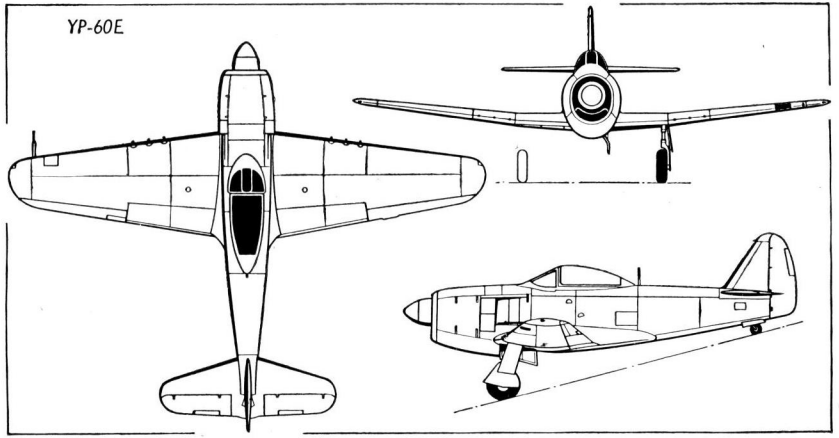
dismantled. The XP-60C was, therefore, hurriedly reassembled without the intended modifications being made, and delivered to Patterson Field.

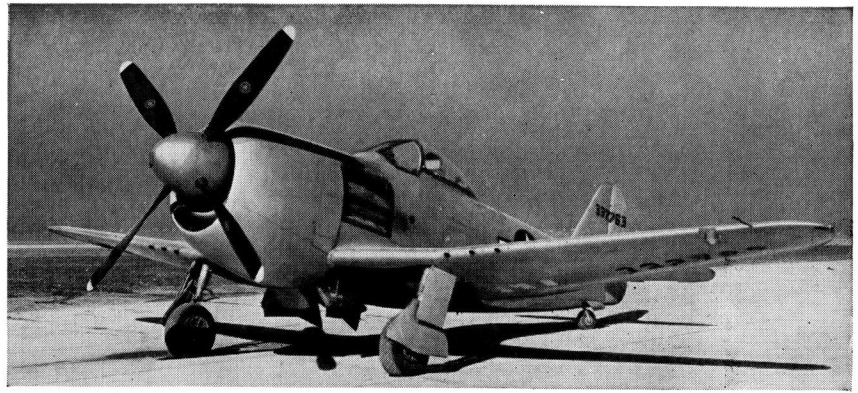
During the trials with the XP-60C at Patterson Field it proved impossible to obtain full power. Also the experimental wing finish had cracked off the leading edge of the wing, destroying the laminar-flow characteristics and resulting in a further loss in speed. In consequence, the XP-60C made a very poor showing and the P-60 Series was virtually eliminated from the production schedules, the contract being reduced from 500 to two aircraft! At this time, work was proceeding on twenty-six P-60A fighters on a pilot production line, and engineering and tooling for full-scale production were being prepared.

Following the return of the XP-60C to Curtiss-Wright, further flight testing was undertaken, but these tests terminated in a forced landing, and in January 1944 the XP-60E was flown to Eglin Field for official trials. The A.A.F. pilots found that the XP-60E did not compare favourably in level flight with later fighters but did possess a comparable climb rate. The aircraft was sensitive to slight changes in flight condition and had to be constantly retrimmed, stability in level flight was poor and climbing speeds were difficult to maintain. In May 1944 Curtiss-Wright indicated their wish to abandon further work on the fighter, but the A.A.F. insisted on the completion of one of the two aircraft still under construction. Originally ordered as YP-60A-1-CUs when the production contract was cancelled, these had been redesignated YP-60E owing to the number of design modifications incorporated and the fact that they were directly descended from the XP-60E.

The first YP-60E was eventually flown on July 13, 1944, and only one further test flight was made before the aircraft was transferred to Wright Field where it was eventually disposed of without further trials. The YP-60E differed from the XP-60E principally in having a 2,100 h.p. R-2800-18 engine and an all-round-vision bubble-type cockpit canopy.

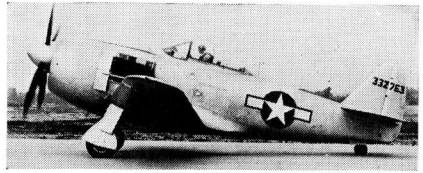
The first of the following specifications relates to the XP-60A with figures in parentheses relating to the XP-60C, and the second specification relates to the XP-60E with figures in parentheses relating to the YP-60E.





(Above and right) The sole YP-60E completed. Only two flight tests were made before the aircraft was abandoned.

Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 1,425 (2,000) *h.p. Allison V-*1710-75 *(Pratt and Whitney R-*2800-53) *twelve-cylinder liquid-cooled (eighteen-cylinder radial air-cooled) engine.* **Armament:** *Six (four)* 0.5-*in. Colt-Browning M*2 *machine guns with* 200 (300) *r.p.g.* **Performance:** *Maximum speed,* 420 (414) *m.p.h. at* 29,000 (20,350) *ft.,* 324 *m.p.h. at sea level; initial climb rate,* 2,560 (3,890) *ft./min.; service ceiling,* 35,200 (37,900) *ft.* **Weights:** *Empty,* 7,806 (8,698) *lb.; normal loaded,* 9,616 (10,785) *lb.* **Dimensions:** *Span,* 41 *ft.* 3¾ *in.; length,* 33 *ft.* 7½ *in.* (33 *ft.* 11 *in.*)*; height,* 12 *ft.* 4¼ *in.; wing area,* 275.15 *sq. ft.*



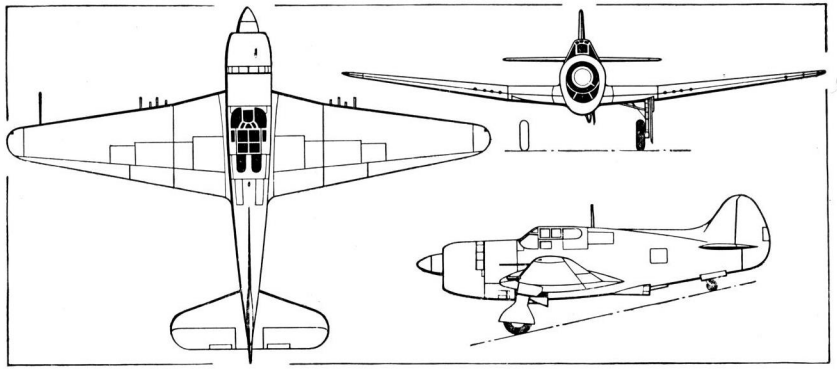
Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 2,000 (2,100) *h.p. Pratt and Whitney R-*2800-10 (-18) *eighteen-cylinder radial air-cooled engine.* **Armament:** *Four* (*six*) 0.5-*in. Colt-Browning M*2 *machine guns with* 250 (267) *r.p.g.* **Performance:** *Maximum speed,* 410 (405) *m.p.h. at* 20,200 (24,500) *ft.; 391 m.p.h. at* 24,200 *ft.; initial climb rate,* 4,200 *ft./min.; service ceiling,* 38,000 (34,000) *ft.* **Weights:** *Empty,* 8,574 (8,285) *lb.; normal loaded,* 10,667 (10,270) *lb.* **Dimensions:** *Span,* 41 *ft.* 3¾ *in.; length,* 33 *ft.* 11 *in.; height,* 12 *ft.* 6 *in.; wing area,* 275.15 *sq. ft.*

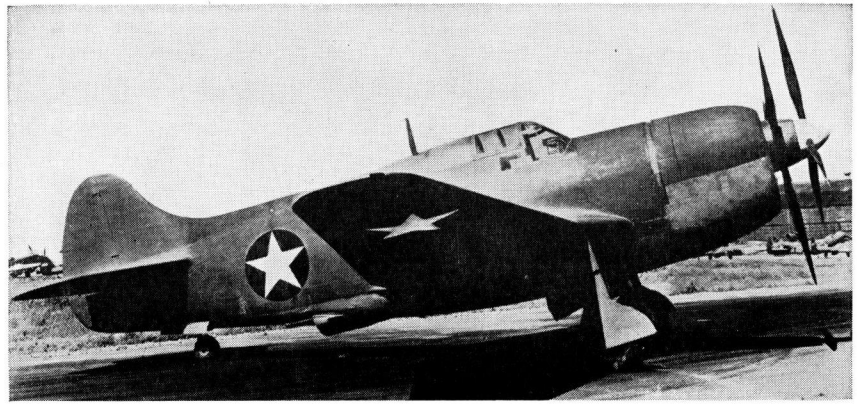
CURTISS XP-62 U.S.A.

In January 1941, Curtiss were asked to design a heavily-armed, high-performance fighter around a new two-row radial air-cooled engine. The terms of the contract stipulated the delivery of the first prototype within fifteen months and a guaranteed maximum speed of 468 m.p.h. at 27,000 ft. The fighter was to feature a pressure cabin, and built-in armament was to comprise either eight 20-mm. cannon or twelve 0.5-in. machine guns. Curtiss's proposals were submitted on April 29, 1941, and these provided for the design and construction of two prototypes, the XP-62 and the XP-62A, the first to be delivered within fifteen months and the second three months later.

Three months later, on August 2, 1941, revised specifications for the XP-62 were submitted for approval, the principal changes being a reduction in maximum speed to 448 m.p.h. with the eight-cannon armament, and an increase of 1,537 lb. in loaded weight. A mock-up inspection was held during the following December and no fewer than ninety changes were recommended. When the status of the XP-62 project was reviewed on January 1, 1942, however, it was recommended that the loaded weight be reduced from 15,568 lb. to 14,000 lb. by a restudy of the structure, the elimination of four cannon, and the removal of the airscrew anti-icing equipment. Proposals were submitted on January 13, 1942 for 100 P-62 fighters, the first machine to be delivered in May 1943, production rising to thirty machines per month by the following October.

A letter contract for 100 P-62s was approved on May 25, 1942, but on July 27th the contract was terminated as it would have affected deliveries of urgently needed Curtiss-built P-47G Thunderbolts. At this time, the XP-62 was 75–80 per cent complete and was scheduled to fly in the April of the following year. One of the most interesting features of the XP-62 was its pressure-cabin supercharger equipment, one of the first such installations in an interceptor fighter, but delays in the delivery of the pressure cabin and necessary engine modifications resulted in the first flight test being delayed until July 21, 1943. The portion of the contract covering the XP-62A was cancelled on September 21, 1943, and a limited amount of flight testing had been conducted with the XP-62 by February 1944 when it was decided to install the pressure cabin for general testing and development work. This cabin had not been fitted for the initial trials, but owing to its low priority, work proceeded slowly, and in the autumn of 1944 the aircraft was scrapped without further flight testing.





Only one XP-62 prototype was completed and flown, a second prototype, the XP-62A, being cancelled.

The XP-62 was not flown sufficiently to secure full performance characteristics, and those quoted in the following specification are the manufacturers' estimates.

Type: *Single-seat High-altitude Interceptor Fighter.* **Power Plant:** *One* 2,300 *h.p. Wright R-3350-17 Cyclone eighteen-cylinder radial air-cooled engine.* **Armament:** *Four* 20-*mm. cannon or eight* 20-*mm. cannon.* **Performance:** *Maximum speed,* 448 *m.p.h. at* 27,000 *ft.,* 358 *m.p.h. at* 5,000 *ft.; normal range,* 900 *mls.; maximum range,* 1,500 *mls.; time to* 15,000 *ft.,* 6.9 *min.; service ceiling,* 35,700 *ft.* **Weights:** *Empty,* 11,773 *lb.; normal loaded,* 14,660 *lb.; maximum,* 16,651 *lb.* **Dimensions:** *Span,* 53 *ft.* 7¾ *in.; length,* 39 *ft.* 6 *in.; height,* 16 *ft.* 3 *in.; wing area,* 420 *sq. ft.*

CURTISS XF14C-2

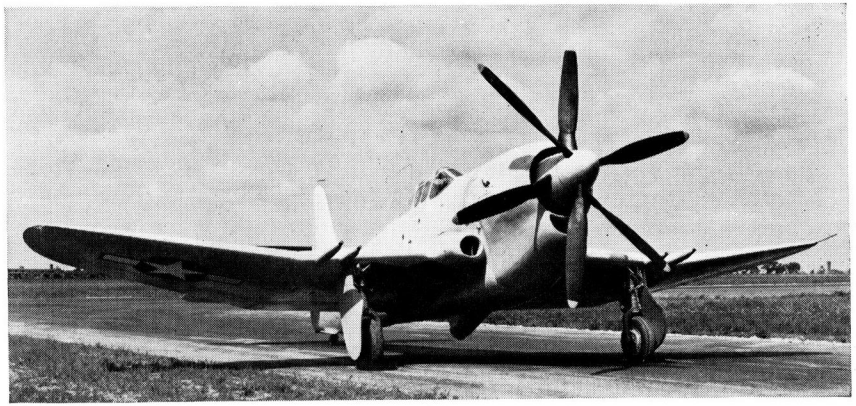
U.S.A.

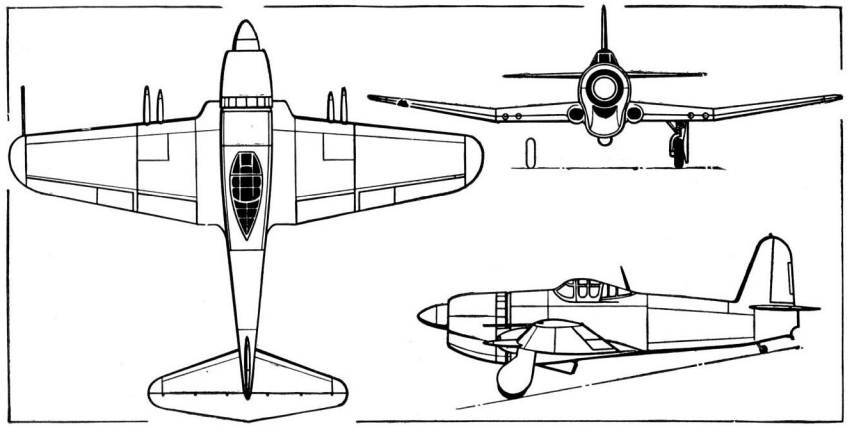
The value of the liquid-cooled engine in high-performance fighters was demonstrated over Europe during the opening stages of World War II, and the U.S. Navy sought to adapt such an engine to its needs, contracting with the Curtiss company to design a ship-board fighter around the new liquid-cooled Lycoming XH-2470 engine. When, on June 30, 1941, five months before the beginning of the Pacific War, the U.S. Navy placed prototype development contracts for a new and more powerful generation of shipboard interceptors, including the single-engined Grumman XF6F-1 and the twin-engined Grumman XF7F-1, Curtiss received an order for two prototypes of the XF14C-1.

The XF14C-1 was to have been powered by an XH-2470-4 engine possessing a military rating of 2,200 h.p. at sea level and a normal maximum rating of 2,000 h.p. at 4,500 ft., and carry an armament of four 20-mm. wing-mounted cannon. Empty weight was 9,868 lb., and loaded weight was 12,691 lb. with 664 rounds of ammunition and 191.5 Imp. gal. of fuel, or 13,868 lb. with 800 rounds and 316.4 Imp. gal. At the lower loaded weight, it was estimated that the XF14C-1 would attain maximum speeds of 334 m.p.h. at sea level, 374 m.p.h. at 17,000 ft., and 327 m.p.h. at 27,000 ft., while initial climb rate and service ceiling were expected to be 2,810 ft./min. and 30,500 ft. respectively.

At a relatively early stage in the programme the U.S. Navy was demanding a better altitude

Flown for the first time in July 1944, *the XF*14C-2 *proved to possess a disappointing performance.*





performance, and in view of the unsatisfactory state of development of the Lycoming engine, Curtiss adapted the basic design to take the turbo-supercharged Wright R-3350 Cyclone eighteen-cylinder two-row air-cooled radial as the XF14C-2. Accordingly, in December 1943, further work on the XF14C-1 was cancelled. Three-blade contra-rotating airscrews were fitted, and in view of the problems of protracted operation at altitudes of the order of 40,000 ft. foreseen by the U.S. Navy, design studies were initiated on a third model, the XF14C-3 with a pressure cabin. In the event, only the XF14C-2 prototype was completed, this flying for the first time in July 1944. Prior to this event, however, disappointing estimated performance and non-availability of the XR-3350-16 engine combined with the fact that the tactical need for an extremely high altitude fighter had failed to materialise, had resulted in the cancellation of further development of the fighter.

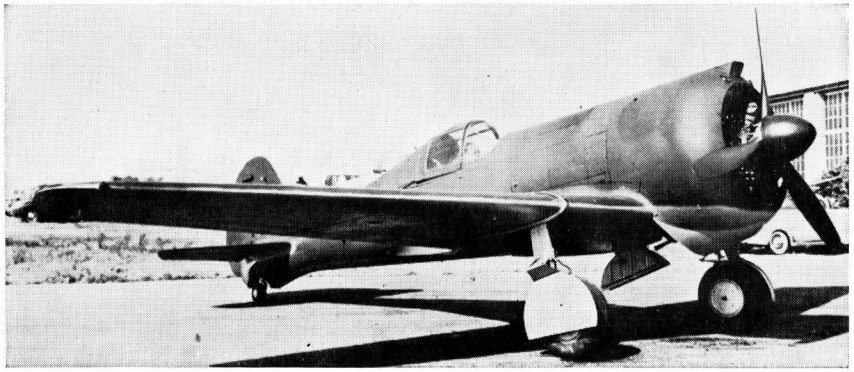
Type: *Single-seat High-altitude Shipboard Interceptor Fighter.* **Power Plant:** *One* 2,300 *h.p. Wright XR*-3350-16 *eighteen-cylinder radial air-cooled engine.* **Armament:** *Four* 20-*mm. cannon.* **Performance:** *Maximum speed,* 317 *m.p.h. at sea level,* 386 *m.p.h. at* 20,000 *ft.,* 424 *m.p.h. at* 32,000 *ft.; range,* 950 *mls. at* 172 *m.p.h.,* 1,355 *mls. at* 162 *m.p.h.; initial climb rate,* 2,700 *ft./min.; time to* 10,000 *ft.,* 3.8 *min., to* 20,000 *ft.,* 7.9 *min.; service ceiling,* 39,500 *ft.* **Weights:** *Empty,* 10,582 *lb.; loaded,* 13,405 *lb.; maximum,* 14,582 *lb.* **Dimensions:** *Span,* 46 *ft.* 0 *in.; length,* 37 *ft.* 9 *in.; height,* 12 *ft.* 4 *in.; wing area,* 375 *sq. ft.*

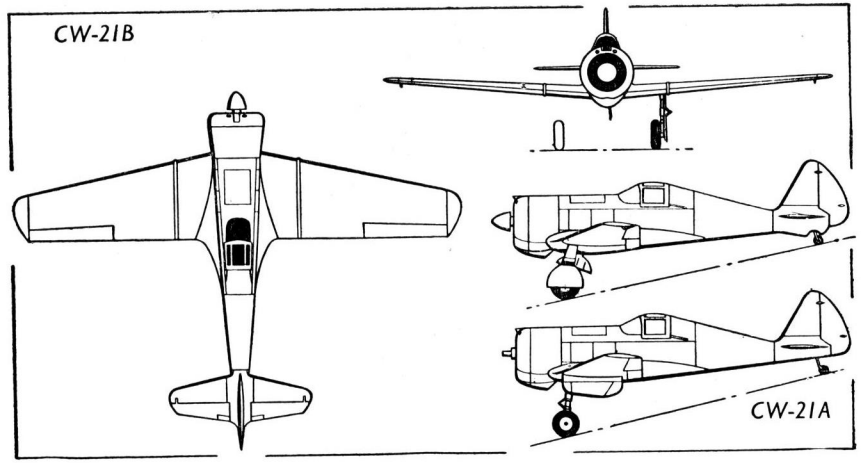
CURTISS-WRIGHT CW-21 DEMON — U.S.A.

In 1938 the St. Louis Airplane Division of the Curtiss-Wright Corporation began the development of a lightweight interceptor fighter based on the design of the CW-19R two-seat general-purpose military monoplane. Known as the CW-21 Demon, the prototype flew in January 1939 and bore the civil experimental registration NX19431. Of all-metal construction, the CW-21 could carry various combinations of 0.3-in. and 0.5-in. machine guns, all synchronised to fire through the airscrew. The main undercarriage members retracted backwards and were completely enclosed by split fairings beneath the wings.

The CW-21 Demon was intended primarily for export, and the first foreign order came from the Chinese government, this calling for three complete aeroplanes, one set of tools and drawings, and thirty-two sets of components. This order was fulfilled in 1939, and in the following year the Netherlands East Indies government placed an order for twenty-four examples of a modified model, the CW-21B. Whereas the armament of the production CW-21 had comprised one 0.3-in. and one 0.5-in. machine gun, the CW-21B carried two guns of each calibre. Fuel tankage was increased slightly (from 80 to 83 Imp. gal.), but the principal change in the later model concerned the undercarriage. A semi-retractable tailwheel replaced the earlier fixed tailwheel, and the underwing fairings for the main undercarriage members were eliminated, the mainwheels retracting inwards into fuselage nacelles. These refinements increased maximum level speed from 304 m.p.h. to 312 m.p.h. at 12,200 ft., although an increase in gross weight from 4,250 lb. to 4,500 lb. reduced climb by 300 ft./min.

One of the CW-21Bs built for the Netherlands East Indies Army Air Corps in 1940–41.





The delivery of CW-21B fighters to the Netherlands East Indies began in June 1940, but only seventeen were on strength with the Army Air Corps on December 8, 1941 when the Netherlands declared war on Japan. Based at Andir, near Bandoeng, Java, the CW-21Bs did not see action until February 3, 1942, when the Japanese assault on Java began. The CW-21B possessed only the most rudimentary pilot protection; it lacked fuel tank protection; its firepower was inadequate, and its light structure was unable to withstand the cannon of the Zero-Sen. In consequence, within two days only five CW-21Bs remained.

Three other CW-21B fighters built were supplied to the American Volunteer Group. Assembled by the Chinese Aircraft Manufacturing Company at Loi-Wing, the three aircraft were delivered to the A.V.G. at Rangoon from where, on December 23, 1941, they took-off for Kunming. However, during the flight they crashed into a mountain in bad visibility, two of the pilots losing their lives.

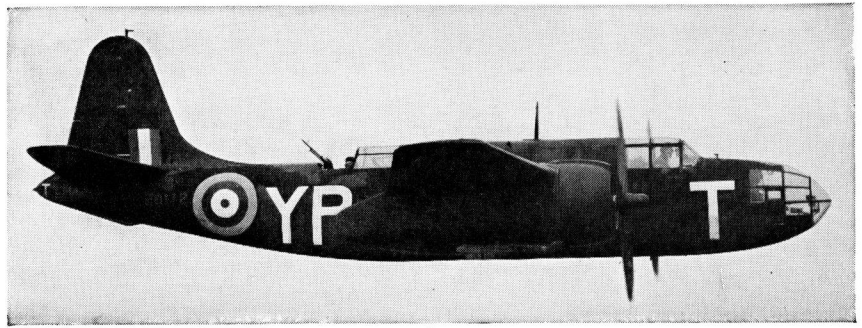
Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 1,000 *h.p. Wright Cyclone R-1820-G5 nine-cylinder radial air-cooled engine.* **Armament:** *Two* 0.3-*in. and two* 0.5-*in. Browning M-2 machine guns.* **Performance:** *Maximum speed,* 315 *m.p.h. at* 17,000 *ft.; maximum cruising speed,* 282 *m.p.h.; range,* 630 *mls.; initial climb rate,* 4,500 *ft./min.; time to* 13,120 *ft.,* 4 *min.; service ceiling,* 34,300 *ft.* **Weights:** *Empty,* 3,382 *lb.; loaded,* 4,500 *lb.* **Dimensions:** *Span,* 35 *ft.* 0 *in.; length,* 27 *ft.* 2 *in.; height,* 8 *ft.* 11 *in.; wing area,* 174.3 *sq. ft.*

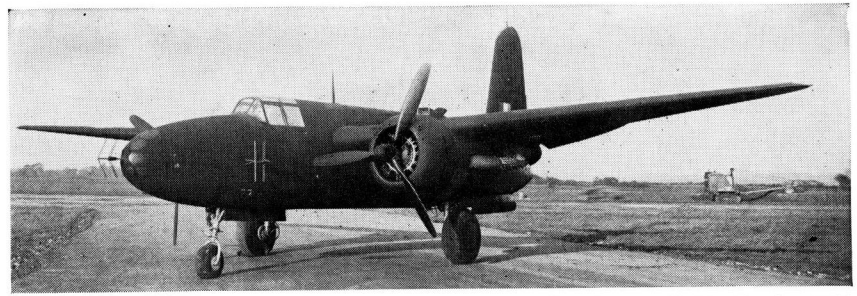
DOUGLAS (DB-7) P-70 HAVOC — U.S.A.

During 1940 the R.A.F. was experiencing a serious shortage of aircraft suitable for night fighting and intruder duties, and capable of carrying the cumbersome early airborne-interception radar. The ex-French contract Douglas DB-7 light bombers that began to arrive in the United Kingdom in the late summer and had been designated Boston IIs appeared to be suitable mounts for such equipment and offered relatively good performance. A conversion programme was therefore planned, and in December 1940 the DB-7 embarked on its new nocturnal role as the Havoc I.

The DB-7s selected for conversion were those powered by Pratt and Whitney R-1830-S3C4G Twin Wasp engines rated at 1,200 h.p. for take-off, earlier DB-7s with the R-1830-SC3G engines, known as Boston Is, being restricted to training and non-operational duties. Conversion was undertaken at the Burtonwood Aircraft Repair Depot during the winter of 1940–41, the first Havoc I being delivered to the R.A.F. in December 1940, and more than 100 conversions being completed in the following few months. Armour protection was provided for the three crew members, flame-damping exhausts were fitted and, originally known as Rangers, about half the Havoc Is were armed with four forward-firing 0.303-in. Browning guns in the lower part of the fuselage nose, and a single Vickers "K" gun of similar calibre in the rear cockpit. A bomb load of up to 2,400 lb. could be carried for intrusion sorties on which the aircraft soon achieved success, particularly with No. 23 Squadron operating from Ford. For pure night fighting duties, the Havoc I was fitted with a "solid" nose housing an additional four 0.303-in. guns and carrying A.I.Mk.VI

A Douglas Havoc I of No. 23 Squadron which undertook intrusion sorties from Ford in the spring of 1941.

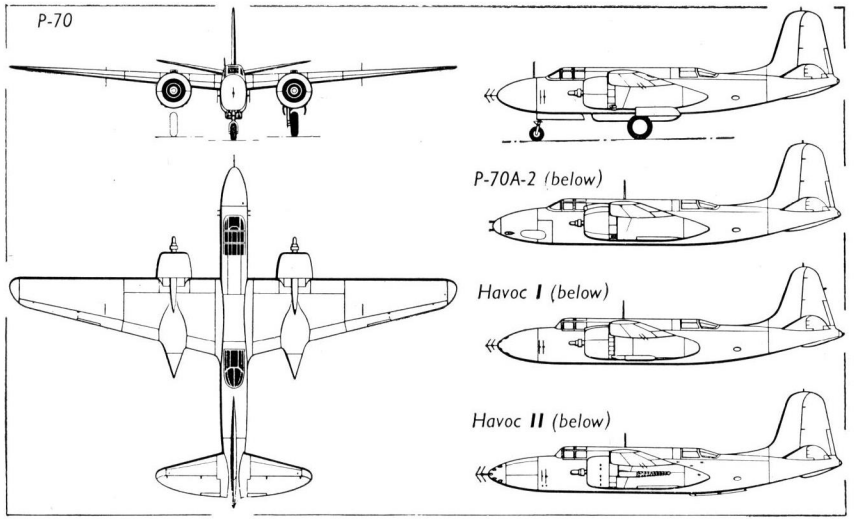




A Douglas Havoc II with twelve-gun nose and early A.I. radar photographed in October 1941. (*Below*) *One of the thirty-nine Havoc IIs fitted with a Turbinlite.*

radar. No. 93 Squadron received twenty modified Havoc I (Pandora) aircraft, "Pandora" being the code name for the Long Aerial Mine, an explosive charge on 2,000 feet of cable which was stowed in the bomb-bay of the Havoc and trailed in the path of hostile bombers. This device did not prove successful, and the unit was disbanded in November 1941.

Another modified version was the Havoc I Turbinlite. Thirty-one Havoc Is were modified to mount the 2,700 million candlepower Helmore/G.E.C. searchlight, known as a Turbinlite, in conjunction with the early A.I. radar. As the nose was fully occupied with equip-

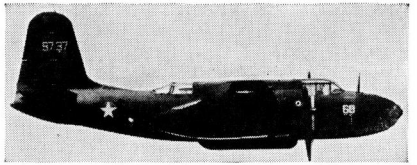


ment, and the bomb-bay was full of batteries, the Turbinlite Havocs were unarmed, and depended upon accompanying Hurricanes to destroy the quarry which they were supposed to illuminate.

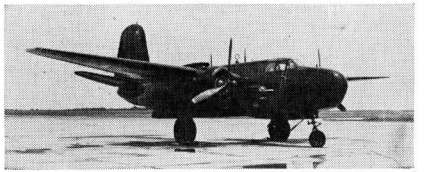
The R.A.F. also inherited a French contract for one hundred DB-7As powered by the 1,600 h.p. Wright R-2600-A5B Cyclone. These engines were accommodated in lengthened nacelles and, as a corollary to the increased power, the vertical tail surfaces were substantially increased in area. Ninety-nine of the DB-7As were converted as Havoc IIs and some eighty of these became twelve-gun night fighters. These were fitted with a new nose housing no less than twelve 0.303-in. Brownings, this installation being made possible by the ingenious arrangement of the guns and the use of Martin ammunition boxes. Thirty-nine Havoc IIs were modified to carry Turbinlite equipment before the development of centimetric radar rendered this obsolete. The DB-7B ordered by Britain as the Boston III was generally similar to the Havoc II except for a revised hydraulic system, fuel system and instrument layout, and at least three Boston IIIs were converted as Turbinlite aircraft while several dozen were modified for intruder operations on the Havoc I pattern. The Boston III (Intruder) aircraft retained their transparent noses but were painted matt black, equipped with flame-damping exhausts, and fitted with a belly gun pack housing four 20-mm. Hispano cannon. These operated from mid-1942 onwards with Nos. 418 (R.C.A.F.) and 605 Squadrons.

The U.S.A.A.C. had ordered the development of a specialised night fighter, the XP-61, on January 11, 1941, but in view of R.A.F. experience, it was decided to adapt the Army Air Corps' equivalent of the DB-7B, the A-20, as an interim night fighter. The A-20 prototype was re-engined with unsupercharged R-2600-11 Cyclone engines, the original turbo-supercharged R-2600-7s having suffered serious cooling difficulties, fitted with early British A.I. radar in a "solid" nose similar to that of the R.A.F.'s Havoc and, with two crew members, carried four 20-mm. cannon in a fairing beneath the fuselage. This aircraft became known as the XP-70, serving as a prototype for the conversion of a further fifty-nine A-20s as P-70 night fighters. These were delivered between April and September 1942, and were used largely for training squadrons awaiting the delivery of Northrop P-61s in the new art of radar interception. In 1943, thirty-nine A-20Cs were modified as P-70A-1s, these having six 0.5-in. guns and radar in a "solid" nose, and sixty-five A-20Gs were converted as P-70A-2s, these retaining the standard G-model nose armament. One A-20G-10-DO was fitted with a "solid" nose housing radar, and with three 0.5-in. guns in large blisters on each side of the fuselage became the sole P-70B-1. One hundred and five A-20Gs and Js were equipped as night fighter trainers under the designation P-70B-2.

The P-70A saw limited action in the Pacific where they were replaced by Northrop P-61 Black Widows in 1944. The name "Havoc", first applied to R.A.F. night fighting versions of the DB-7, was later adopted by the A.A.F. for the A-20 attack bomber versions of the basic design but was not applied to the P-70.



(*Above*) *The second Douglas P-70* (39-737).



(*Above*) *The sole Douglas P-70B-1.*

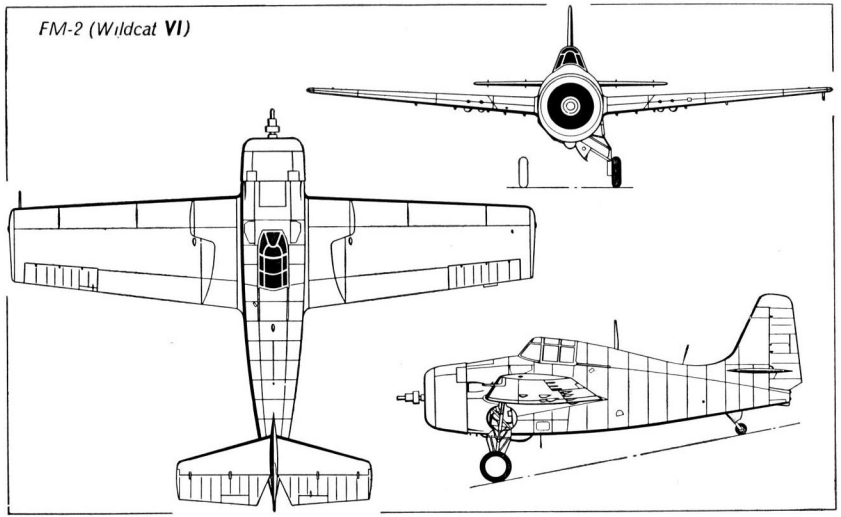
The following specification relates to the R.A.F.'s Havoc I, figures in parentheses referring to the P-70.

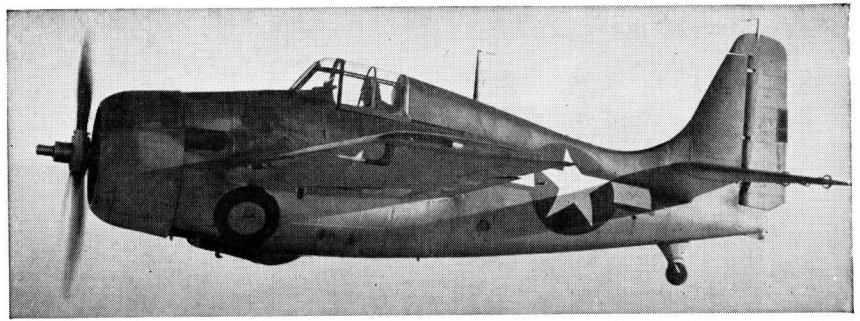
Type: *Two-seat Night Fighter.* **Power Plants:** *Two* 1,200 (1,600) *h.p. Pratt and Whitney R-1830-S3C4G Twin Wasp* (*Wright R-2600-11 Double Cyclone*) *fourteen-cylinder radial air-cooled engines.* **Armament:** *Eight* 0.303-*in. machine guns* (*four* 20-*mm. cannon*). **Performance:** *Maximum speed*, 295 (329) *m.p.h. at* 13,000 (14,000) *ft.; cruising speed*, (270) *m.p.h.; range*, 996 (1,040) *mls.; time to* 12,000 *ft.*, (8) *min.; service ceiling*, 25,800 (28,250) *ft.* **Weights:** *Empty*, 11,400 (16,031) *lb.; loaded*, 19,040 (21,264) *lb.* **Dimensions:** *Span*, 61 *ft.* 4 *in.; length*, 46 *ft.* 11¾ *in.* (47 *ft.* 7 *in.*)*; height*, 15 *ft.* 10 *in.* (17 *ft.* 7 *in.*)*; wing area*, 464.8 *sq. ft.*

GENERAL MOTORS FM-1–FM-2 WILDCAT U.S.A.

From the outset, the Wildcat had possessed an inferior performance to that of the Japanese Zero-Sen fighter, but it was a sturdy and reliable aircraft, capable of operating effectively from small escort carriers and MAC-ships. Thus, when Grumman's Bethpage factory's facilities were required for the F6F-3 Hellcat, urgently needed by the U.S. Navy to establish a margin of ascendancy over enemy fighters, production of the Wildcat was transferred to the Eastern Aircraft Division of General Motors which completed and flew its first Wildcat on September 1, 1942. Designated FM-1, this was essentially similar to Grumman's F4F-4, the principal change being a reduction in the number of wing-mounted 0.5-in. guns from six to four, and an increase in the ammunition capacity from 1,440 to 1,720 rounds. The R-1830-86 Twin Wasp engine was retained, and twenty-three FM-1 Wildcats had been produced by the end of 1942.

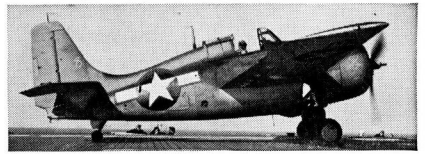
A further 1,127 FM-1 Wildcats were built

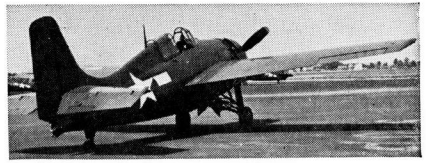




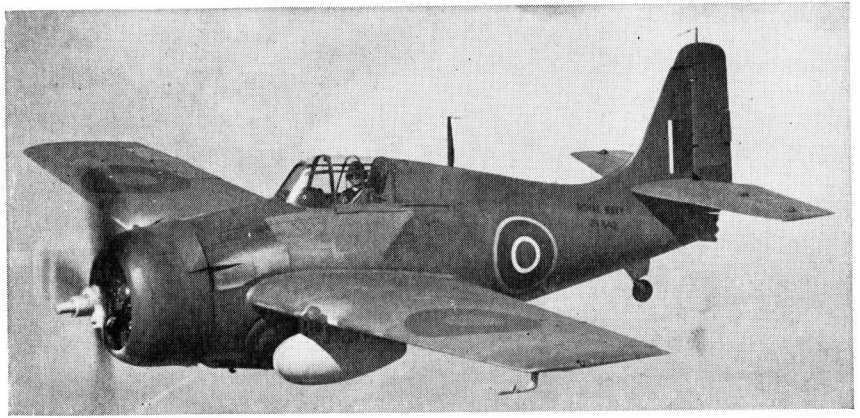
(Above and right) The General Motors FM-2 Wildcat, 4,777 examples of which were produced.

by General Motors in 1943, and of these 312 were supplied to Britain under Lend-Lease as the Martlet V, these serving primarily from light escort carriers, working in collaboration with Swordfish rocket-firing aircraft in attacks on U-boats. In September 1943, delivery began of a substantially revised model, the FM-2. This was the first model of the Wildcat produced for the U.S. Navy to standardise on the Cyclone engine, although the British Martlet I and IV had been fitted with this power plant. The FM-2 was the production version of the Grumman-built XF4F-8, two examples of which were tested in December 1942, but differed from the prototypes in having redesigned vertical tail surfaces. The Cyclone was of the much improved R-1820-56 version which, incorporating a turbo-supercharger, offered 1,350 h.p. for take-off and 1,000 h.p. at 14,700 ft. Production of the FM-2 continued until August 1945 when 4,777 examples of this model had been built, 3,130 of them being turned out in 1944. Three hundred and seventy FM-2s were supplied to the British

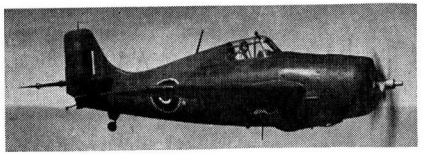




Fleet Air Arm by which they were known as the Wildcat VI (the U.S. Navy name for the fighter having been adopted in January 1944), the first unit to re-equip with this type being No. 881 Squadron which became operational



(Above) A General Motors Wildcat VI (FM-2) of the F.A.A., this service receiving 370 *of these.*



A General Motors Wildcat V (FM-1) fighter.

with Wildcat VIs aboard H.M.S. *Pursuer* in July 1944.

In U.S. Navy service, General Motors-built Wildcats accounted for 422 enemy aircraft during 1944–45

The following specification relates to the FM-2, figures in parentheses relating to the FM-1.

Type: *Single-seat Shipboard Fighter-bomber.* **Power Plant:** *One* 1,350 (1,200) *h.p. Wright R-*1820-56 *Cyclone (Pratt and Whitney R-*1830-86 *Twin Wasp) nine- (fourteen-) cylinder radial air-cooled engine.* **Armament:** *Four* 0.5-*in. machine guns with* 430 *r.p.g. plus two* 250-(100-) *lb. bombs or six* 5-*in. rockets.* **Performance:** *Maximum speed,* 332 (320) *m.p.h. at* 28,800 (18,800) *ft.,* 306 (284) *m.p.h. at sea level; economical cruising speed,* 164 (161) *m.p.h.; initial climb rate,* 3,650 (3,300) *ft./min.; service ceiling,* 34,700 (34,000) *ft.; normal range,* 900 (830) *mls.; maximum range,* 1,310 (1,275) *mls.* **Weights:** *Empty,* 5,448 (5,895) *lb.; normal loaded,* 7,487 (7,975) *lb., maximum,* 8,271 (8,762) *lb.* **Dimensions:** *Span,* 38 *ft.* 0 *in.; length,* 28 *ft.* 10⅝ *in.; height,* 9 *ft.* 11 *in.; wing area,* 260 *sq. ft.*

GENERAL MOTORS P-75A EAGLE

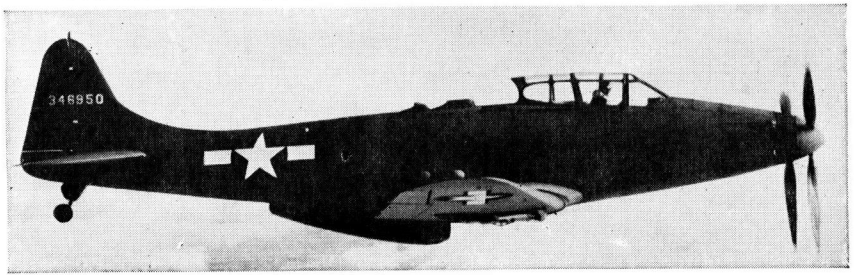
U.S.A.

In 1942 the U.S.A.A.F. found itself to be in urgent need of a fighter possessing an extremely high climb rate, and to meet this requirement the General Motors Corporation submitted a proposal in September 1942 for a fighter employing the most powerful liquid-cooled engine available, the Allison V-3420, and major assemblies from existing aircraft. A contract for two prototypes of the proposed aircraft was awarded General Motors' Fisher Body Division early in October, the aircraft being designated XP-75, and at this time it was proposed to employ the outer wing panels of the P-51 Mustang in an inverted gull arrangement, the tail assembly of the Douglas A-24, and the undercarriage of the F4U Corsair. The general layout of the fighter followed that of the P-39 Airacobra, with the engine located amidships and shaft drive to an airscrew reduction gearbox in the nose, and at an early design stage a straight wing design utilising P-40 Warhawk outer panels supplanted the inverted gull configuration originally proposed.

By the summer of 1943, long-range escort fighters were needed even more urgently than fast-climbing interceptors, and on July 6, 1943, it was decided to order six additional XP-75s modified for the long-range role. Simultaneously, it was decided to order 2,500 production machines, although it was stipulated that if the first production P-75A did not meet all requirements the complete order might be cancelled. The first XP-75 flew on November 17, 1943, and was powered by a V-3420-19 twenty-four cylinder engine rated at 2,600 h.p. for take-off and driving co-axial contra-rotating airscrews. Total internal fuel capacity was 445 Imp. gal. The stressed-skin wing comprised a straight centre section married to five-spar P-40 outer panels with modified tips. The ailerons were of longer span than the original P-40 ailerons, and the tail assembly was essentially that of the A-24 with minor modifications. The main undercarriage members employed F4U Corsair components.

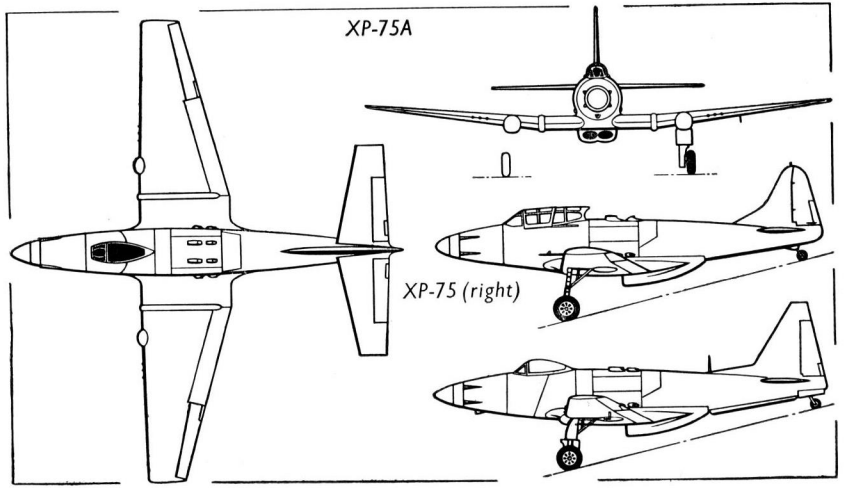
The second XP-75 flew shortly after the first machine, and all six XP-75 long-range escort fighter prototypes had been phased into the flight test programme by the spring of 1944.

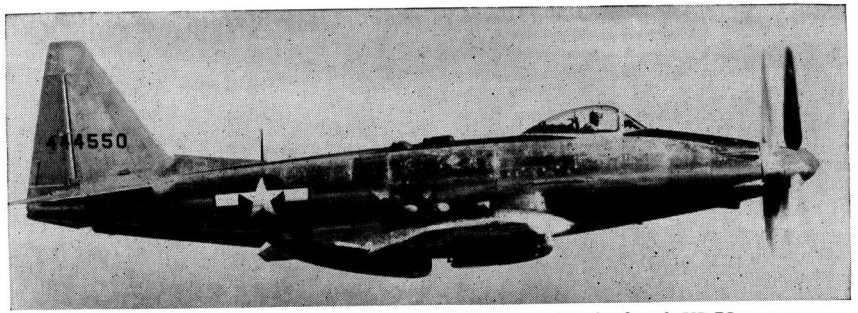
*The first XP-*75 *interceptor prototype* (43-46950) *which flew on November* 17, 1943.



A considerable number of shortcomings soon manifested themselves. An inaccurate estimate of the fighter's c.g. position resulted in some instability; the engine failed to give its full rated power; engine cooling was inadequate; aileron forces were too high at high speeds, and spinning characteristics were poor. Some redesign had been introduced in the long-range XP-75s which featured a modified tail assembly, a new cockpit canopy and a V-3420-23 engine, and most of the teething troubles had been ironed out when the first P-75A Eagle was ready for flight testing in September 1944. By that time, the A.A.F. had decided to limit the number of combat types in production and not embark on the large-scale production of new types which might not be available in effective numbers before the war ended. As the P-47D Thunderbolt and the P-51D Mustang had proved to have excellent long-range capabilities, the production contract for the P-75A Eagle was substantially terminated on October 6, 1944. At this time, the first and second P-75As had been delivered to Eglin Field, Florida, for tactical suitability trials, although the first machine had already been destroyed in a crash, the fourth and fifth P-75As were virtually complete, and the third machine was having an experimental intercooler fitted.

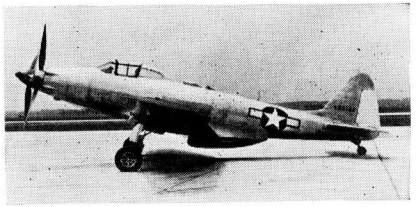
It was decided to complete these machines for experimental work and development on the V-3420 engine, the sixth machine being placed in storage as a source of spare parts. The five





(Above) The second production P-75A Eagle and (below, right) the fourth XP-75 prototype.

production P-75A Eagles never completed official performance trials, however, owing to the termination of the production contract, although sufficient tests were conducted to display the fact that maximum speed was some 30 m.p.h. below that guaranteed by the manufacturer, and it was to correct this that the third production machine received an experimental intercooler installation which permitted substantial increases in engine power. The flight testing of the XP-75 prototypes by the manufacturer was largely confined to eliminating the various troubles suffered by the design, and the maximum speed attained during these tests was 418 m.p.h. at 21,600 ft. with the third prototype at 13,600 lb. As no official performance tests were conducted, the figures quoted in the following specification for the long-range XP-75 are those quoted by the manufacturer.



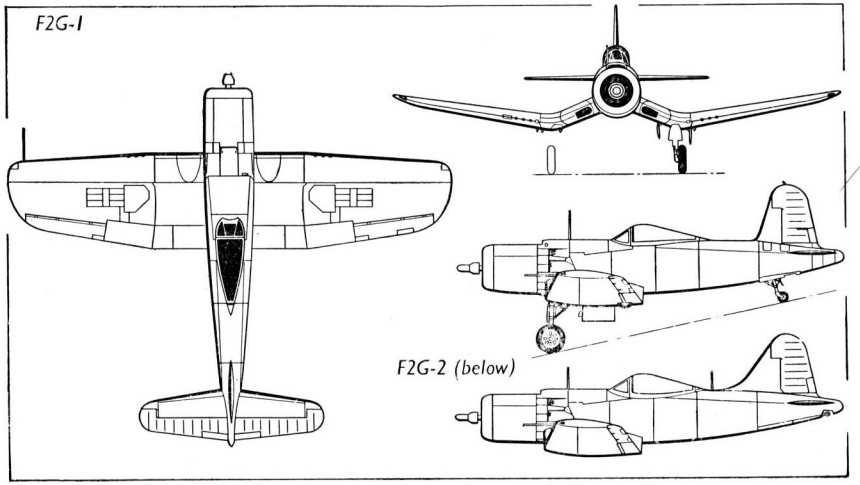
Type: *Single-seat Long-range Escort Fighter.* **Power Plant:** *One* 2,885 *h.p. Allison V*-3420-23 *twenty-four cylinder liquid-cooled engine.* **Armament:** (*P-75A*) *Six* 0.5-*in. machine guns with* 235 *r.p.g. in wings and four* 0.5 *in. guns with* 300 *r.p.g. in fuselage, plus two* 500-*lb. bombs.* **Performance:** *Maximum speed,* 433 *m.p.h. at* 20,000 *ft.; cruising speed,* 314 *m.p.h.; initial climb rate,* 4,200 *ft./min., at* 10,000 *ft.,* 3,900 *ft./min., at* 20,000 *ft.,* 3,200 *ft./min.; service ceiling,* 36,400 *ft.; absolute ceiling,* 39,500 *ft.; range,* 2,050 *mls., (with maximum external fuel),* 3,500 *mls. at* 314 *m.p.h. at* 20,000 *ft.* **Weights:** *Empty,* 11,495 *lb.; normal loaded,* 13,807 *lb.; maximum,* 18,210 *lb.* **Dimensions:** *Span,* 49 *ft.* 4 *in.; length,* 40 *ft.* 5 *in.; height,* 15 *ft.* 6 *in.; wing area,* 347 *sq. ft.*

GOODYEAR F2G-1 — U.S.A.

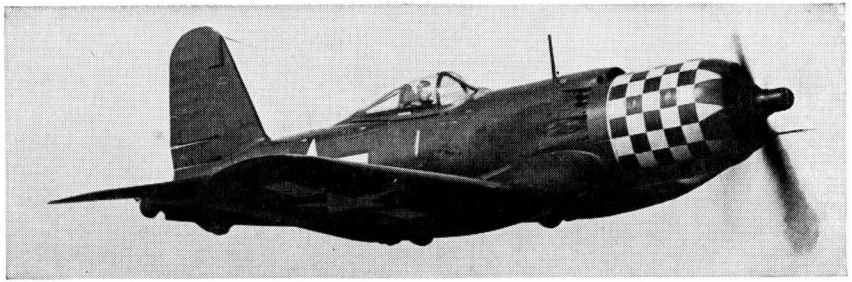
The Goodyear Aircraft Corporation began to participate in the Vought Corsair production programme in 1942, initially manufacturing a fixed-wing version of the F4U-1 as the FG-1 (see pages 188–194). A certain amount of development work on the basic design was undertaken by Goodyear who, early in 1944, were asked to evolve a special low-altitude version of the fighter with a Pratt and Whitney R-4360 twenty-eight cylinder four-row radial, this being intended for U.S. Marine Corps use as an interceptor for low-flying Japanese suicide aircraft.

A standard FG-1 airframe was modified to flight test the R-4360 engine as the XF2G-1 and, in March 1944, Goodyear was awarded contracts for 418 F2G-1s and ten F2G-2s, the former being land-based and the latter being equipped to operate from carriers. The fuselage of the F2G-1 was extensively redesigned to make full use of the fifty per cent increase in take-off power offered by the new engine, and an all-round vision bubble-type cockpit canopy was adopted, this canopy being somewhat different in contour to that tested earlier on two FG-1As as a proposed production modification to the original Goodyear-built version of the Corsair. It was proposed to install a water injection system to boost the engine's emergency rating to 3,650 h.p., and with the aid of this system a maximum speed of 450 m.p.h. was anticipated at 16,500 ft. Alternative wing-mounted armaments comprised four or six 0.5-in. machine guns, and eight 5-in. rocket projectiles or two 1,000-lb. or 1,600-lb. bombs could be carried. Internal fuel capacity was increased substantially to 257 Imp. gal., and this could be augmented by two 125 Imp. gal. drop tanks.

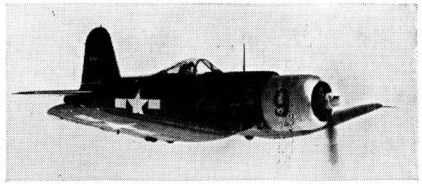
Only five F2G-1s and five F2G-2s had been completed by V-J Day when further production of these fighters was cancelled.



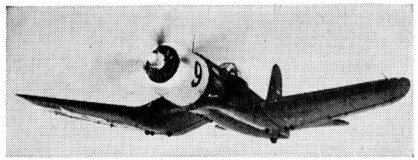
Type: *Single-seat Low-altitude Interceptor and Fighter-bomber.* **Power Plant:** *One* 3,000 *h.p. Pratt and Whitney R-4360-4 Wasp Major twenty-eight cylinder radial air-cooled engine.* **Armament:** *Four* 0.5-*in. machine guns with* 300 *r.p.g. plus eight* 5-*in. rockets or two* 1,000-*lb. or* 1,600-*lb. bombs.* **Performance:** *Maximum speed,* 399 *m.p.h. at sea level,* 431 *m.p.h. at* 16,400 *ft.; initial climb rate,* 4,400 *ft./min., service ceiling,* 38,800 *ft.; range (internal fuel),* 1,190 *mls., (with two* 125 *Imp. gal. drop tanks),* 1,955 *mls.* **Weights:** (*F2G-2*) *Empty,* 10,249 *lb.; normal loaded,* 13,346 *lb.; maximum,* 15,422 *lb.* **Dimensions:** *Span,* 41 *ft.* 0 *in.; length,* 33 *ft.* 9 *in.; height,* 16 *ft.* 1 *in.; wing area,* 314 *sq. ft.*



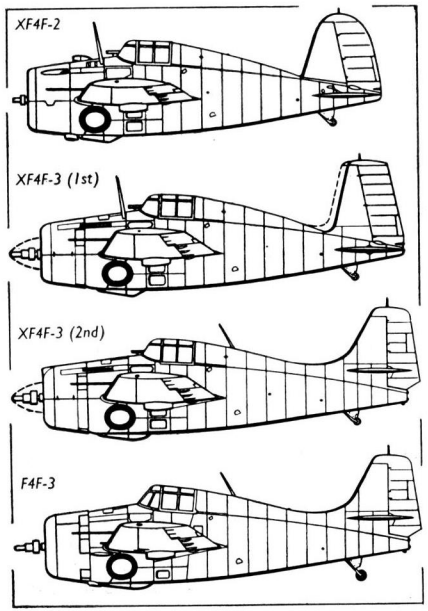
One of the five shipboard Goodyear F2G-2 interceptors completed before V-J Day.



(*Above and below*) *The Goodyear XF2G-1.*

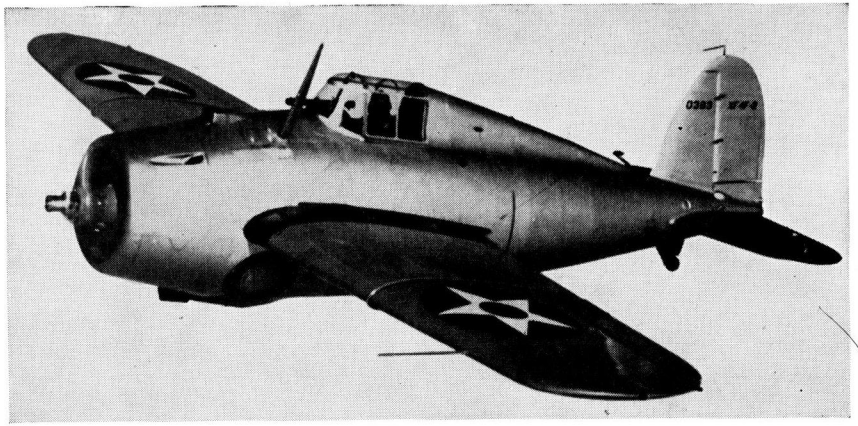


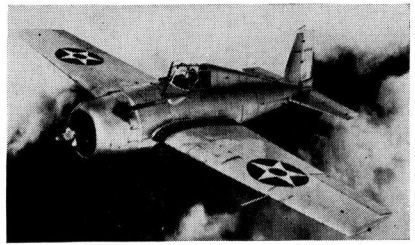
Retaining the characteristic rotund fuselage of the long line of naval fighting biplanes from the same stable, the Grumman G-36, which was to establish a distinguished service record as the Wildcat, represented a notable advance in shipboard warplane design. In fact, it can be considered as the first successful shipboard fighter monoplane, although its beginnings were singularly inauspicious, and so disappointing were the results of initial trials that, early in its career, it appeared unlikely that the G-36 would progress further than the prototype stage.



In 1936 the U.S. Navy placed a development order with the Brewster Aeronautical Corporation for a single-seat shipboard fighter monoplane, the XF2A-1, but owing to lingering doubts regarding the ability of high-powered monoplanes to operate successfully from carrier decks, the development of a new Grumman fighter biplane, the XF4F-1, had been ordered on March 2, 1936 as a safeguard against the failure of the more advanced monoplane. It soon became evident, however, that the biplane would be unable to compete with the monoplane on the score of speed, and the XF4F-1 with its Pratt and Whitney R-1535-66 Wasp radial offered only a marginal performance improvement over the F3F-1s then being delivered to the Navy. Thus, on August 28, 1936, the Grumman project was restarted as the XF4F-2 monoplane, a direct competitor to Brewster's XF2A-1.

The XF4F-2, which bore the manufacturer's designation G-36, was flown for the first time on September 2, 1937, completing manufacturers' trials on December 23rd. Powered by a Pratt and Whitney R-1830-66 Wasp radial with a single-stage supercharger rated at 1,050 h.p. for take-off and 900 h.p. at 10,000 ft., the XF4F-2 had a gross weight of 5,535 lb. Its performance was somewhat disappointing and, although it was marginally faster than the XF2A-1, maximum speed being 288 m.p.h. at 10,000 ft., it was generally inferior to the Brewster fighter in most other respects. Thus, in June 1938, a production order was placed for the Brewster fighter, and three months later



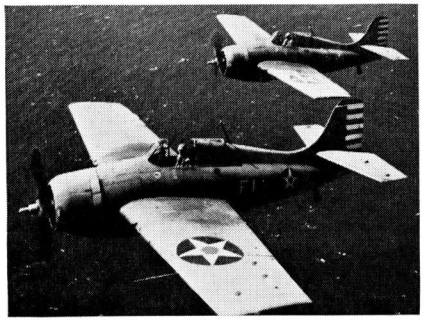


(*Above*) *The Grumman XF4F-2 and* (*below, right*) *the same aircraft as the XF4F-3.*

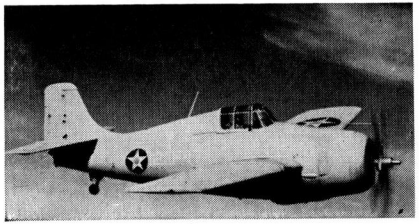
the XF4F-2 was returned to Grumman for a major rework.

Several major changes were made to the prototype during reconstruction, the most important being the installation of the XR-1830-76 engine with a two-stage supercharger offering 1,200 h.p. for take-off and 1,000 h.p. at 19,000 ft. This was accompanied by the introduction of new wings of increased span and gross area, the former being raised from 34 ft. to 38 ft. and the latter from 232 to 260 sq. ft. The rounded wingtips were squared-off, and redesigned, square-cut tail surfaces were fitted. The installation of the two 0.3-in. machine guns in the forward fuselage decking was modified and, as the XF4F-3, the prototype resumed trials in March 1939. During the test programme the XF4F-3 was flown both with and without an airscrew spinner, and the vertical fin was enlarged. It was joined in the programme by a second XF4F-3 which featured a further redesign of the vertical surfaces, a raised tailplane (similar to that later adopted

(*Above*) *Second XF4F-3 Wildcat prototype.*



(*Above*) *Standard fixed-wing F4F-3 Wildcats of the U.S. Navy and* (*below*) *the F4F-3A which differed in having an R-*1830-90 *engine in place of the* -76.



for production machines), and an intake in the upper lip of the engine cowling.

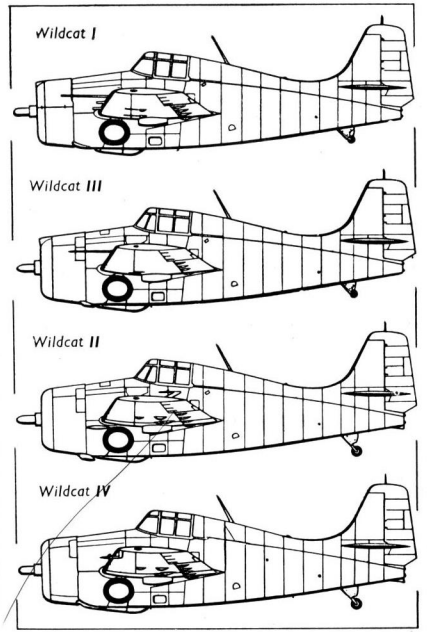
Trials with the XF4F-3 were extremely successful, and in its finalised form, weighing 4,907 lb. empty and 6,103 lb. loaded, the fighter attained maximum speeds of 284 m.p.h. at sea level and 335 m.p.h. at 21,300 ft. Initial climb rate was 3,100 ft./min., and service ceiling was 33,500 ft. Manoeuvrability and climb rate were superior to most land-based contemporaries and, on August 8, 1939, the U.S. Navy placed a contract with Grumman for seventy-eight production F4F-3s. Simultaneously, Grumman offered export models with four alternative engines and was successful in obtaining orders from the French government for eighty-one G-36As powered by the Wright R-1820-G205A rated at 1,000 h.p. at 13,500 ft., and from the Greek government for thirty G-36As powered by the Pratt and Whitney R-1830-S3C4G rated at 1,000 h.p. at 11,500 ft. These, like the F4F-3, had fixed wings, and armament comprised four wing-mounted 0.5-in. guns, those of the French machines being more widely spaced than those of the Greek machines.

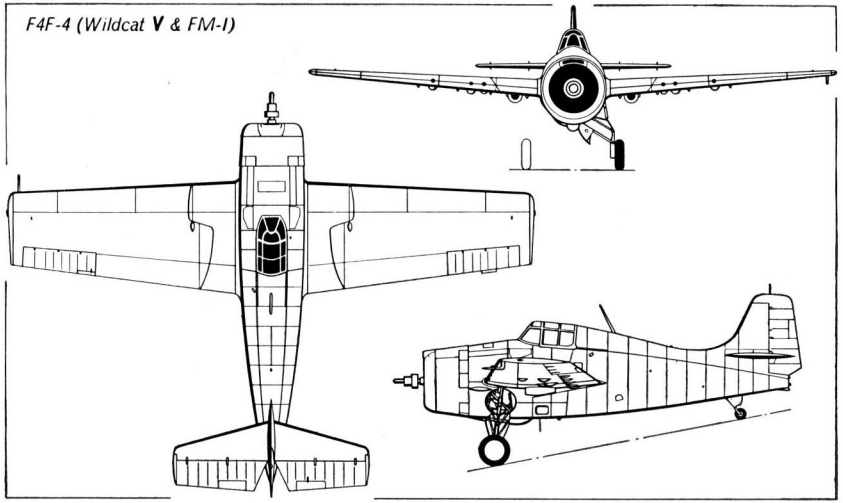
The first G-36A for the French Navy was flown on July 27, 1940, by which time the French government had capitulated and the contract was, therefore, taken over by the British Purchasing Commission which increased the order to ninety machines. In British service the G-36A was designated Martlet I. The first five aircraft were delivered to Canada and the remaining eighty-five reached the United Kingdom where, in October 1940, the type entered service with No. 804 Squadron of the Fleet Air Arm at Hatston. The Martlet I gained the distinction of becoming the first U.S. aircraft in British service to shoot down a German machine in World War II, this event occurring on December 25, 1940 when two Martlet Is of No. 804

Squadron patrolling Scapa Flow intercepted and destroyed a Junkers Ju 88.

Production of the F4F-3 for the U.S. Navy proceeded in parallel with that of the Martlet for Britain, and the first F4F-3 was flown on August 20, 1940, powered by an R-1830-76 Twin Wasp rated at 1,200 h.p. for take-off and 1,000 h.p. at 19,000 ft. The first delivery of the F4F-3 to a Fleet squadron (VF-41) took place on December 4, 1940, a total of 103 F4Fs and Martlets having been completed by the end of the year, this total including two XF4F-5s powered by the Wright R-1820-40 rated at 1,200 h.p. for take-off and 900 h.p. at 14,000 ft. The thirty Greek contract G-36As (S3C4G Twin Wasp) were purchased from Lend-Lease funds and supplied to Britain as Martlet IIIs, and a further sixty-five aircraft (R-1830–90) were built for the U.S. Navy as F4F-3As, these being identical to the Martlet III apart from certain items of equipment. In fact, ten of the F4F-3As were shipped to the U.K. as Martlet IIIs in lieu of ten G-36B (Martlet II) fighters from a batch of one hundred machines ordered by Britain, the G-36B being the first model to feature wing folding for carrier stowage. The G-36B Martlet II, similarly powered to the Martlet III, was fitted with catapult spools, a larger tailwheel, a wing-mounted armament of six 0.5-in. guns, and had no intake in the upper lip of the engine cowling. Thirty-six Martlet IIs were delivered to the U.K., and the remaining fifty-four were shipped to the Far East, and, by virtue of its folding wings, this version of the Grumman fighter was the first of the series to be embarked in British aircraft carriers. On September 20, 1941, Martlet IIs of No. 802 Squadron operating from the small escort carrier H.M.S. *Audacity* destroyed an Fw 200C Condor of K.G.40 which had been shadowing the convoy escorted by the *Audacity*, and during the second voyage of this carrier No. 802's Martlets destroyed no less than four Condors.

During 1941 a total of 323 of the Grumman fighters was produced, including a further 107 fixed-wing F4F-3s and the first of 1,269 F4F-4s, the first U.S. Navy model to have folding wings. The valuable experience gained by Britain's Fleet Air Arm with the Martlet was passed to the U.S. Navy and contributed



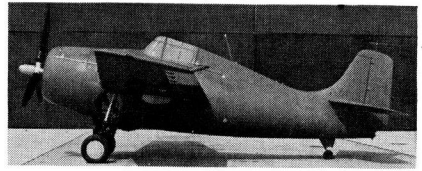


in no small measure to the increase in the fighting efficiency of the Grumman F4F which, in 1941, was officially named Wildcat in U.S. service (this name being standardised by the Royal Navy in January 1944). Much of this experience was incorporated in the F4F-4 which featured the six-gun armament of the Martlet II, 164 lb. of armour and a self-sealing fuel tank. The prototype of this model, the XF4F-4, was flown in May 1941, and in November F4F-4 Wildcats began to re-equip carrier squadrons.

When the Japanese attacked Pearl Harbour, several U.S. Marine Corps squadrons were operating the fixed-wing Wildcat, including VMF-121 and -211 with F4F-3s and VMF-111 with F4F-3As, and the first Wildcats to fight were those of VMF-211 serving on Wake Island. The epic defence of the island by VMF-211 was to become legendary. In the first Japanese attack on the island on December 8, 1941 eight of the twelve F4F-3 Wildcats were destroyed, but the remaining four were flown continuously, fighting heroically for two weeks, breaking up many air attacks and sinking a cruiser and a submarine with 100-lb. bombs before the last two Wildcats were destroyed on December 22nd., the day the Japanese landed on the island. By 1942, the F4F-4 equipped all U.S. carrier fighter

squadrons, and remained the sole American shipboard fighter in service for the first half of the war, participating in all major naval battles and destroying 905 enemy aircraft during 1941–43 for the loss of 178 machines.

A Lend-Lease version of the F4F-4 for the Fleet Air Arm was the F4F-4B, or Martlet IV (later Wildcat IV), which differed from its U.S. Navy counterpart principally in having a Wright GR-1820-G205A-3 Cyclone in place of the R-1830-86 Twin Wasp. Two hundred and twenty Martlet IVs were delivered to the U.K., and the first F.A.A. squadron to equip with this type was No. 892, which took delivery of its first aircraft on July 15, 1942 and subsequently embarked on the escort carriers *Archer* and *Battler*. Among the more noteworthy actions in which the Martlet participated were the landings on Madagascar during which Nos. 881 and 882 Squadrons operated from the *Illustrious*, and the Allied invasion of North Africa during which a Martlet of No. 882 Squadron operating from the *Victorious* took the surrender of the French fighter airfield at Blida. Martlets even operated

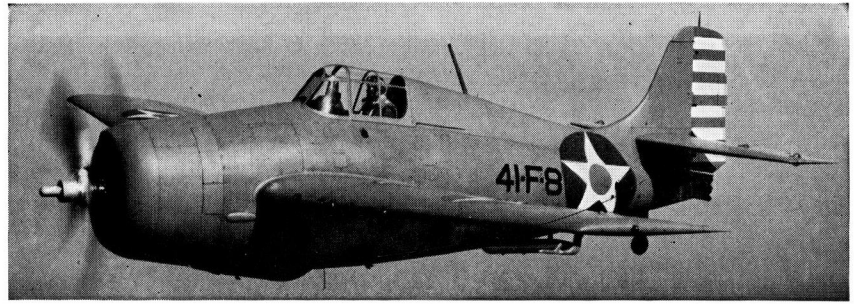


(*Above*) *The XF4F-4 and* (*below*) *the XF4F-5.*

in the Western Desert with No. 805 Squadron based at Dekheila.

A total of 1,445 Wildcats and Martlets was

The first U.S. Navy production variant of the Wildcat to feature wing folding, the F4F-4.

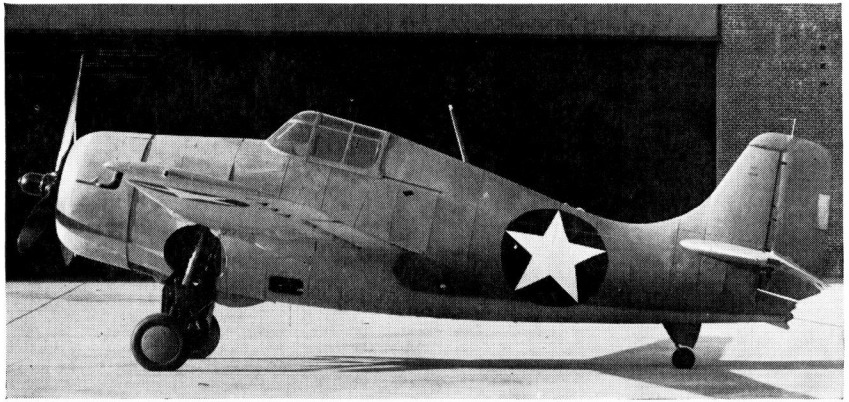


produced in 1942, including twenty-one F4F-7s and two XF4F-8s. The F4F-7 was a long-range reconnaissance version in which the armament was replaced by unprotected fuel tanks, raising total fuel capacity to 570 Imp. gal., and cameras were mounted in the fuselage belly. The XF4F-8s, which began trials in December 1942, were prototypes for the General Motors FM-2 which is dealt with on pages 82–4. Grumman produced a further 100 F4F-4 Wildcats in 1943, production terminating in May of that year in order that the Bethpage plant could concentrate on the more advanced F6F Hellcat. Grumman had then produced 1,971 G-36 fighters but U.S. Navy requirements for this useful little warplane were still growing and, in consequence, the Eastern Aircraft Division of General Motors took over Wildcat production, building the fighter under the designation FM-1.

The following specification relates to the F4F-3, figures in parentheses referring to the F4F-4.

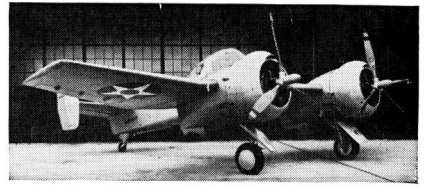
Type: *Single-seat (Shipboard) Fighter-bomber.* **Power Plant:** *One* 1,200 *h.p. Pratt and Whitney R-1830-76 (-86) Twin Wasp fourteen-cylinder radial air-cooled engine.* **Armament:** *Four (six)* 0.5-*in. machine guns and two* 100-*lb. bombs.* **Performance:** *Maximum speed,* 328 (318) *m.p.h. at* 21,000 (19,400) *ft.,* 281 (275) *m.p.h. at sea level; normal range,* 845 (770) *mls.; initial climb rate,* 2,265 (1,950) *ft./min.; service ceiling,* 37,500 (39,400) *ft.* **Weights:** *Empty,* 5,342 (5,758) *lb.; normal loaded,* 7,002 (7,406) *lb.; maximum,* 8,152 (7,952) *lb.* **Dimensions:** *Span,* 38 *ft.* 0 *in.; length,* 28 *ft.* 9 *in.; height,* 9 *ft.* 2½ *in.; wing area,* 260 *sq. ft.*

One of the two XF4F-8 Wildcats which served as prototypes for the General Motors FM-2.



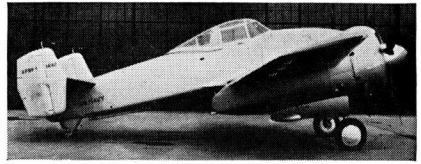
GRUMMAN XF5F-1 U.S.A.

When, in 1938, the Grumman Aircraft Engineering Corporation began design development of the G-34 Skyrocket, their ideas were considered to be revolutionary in the extreme, for at a time when the first single-engined shipboard fighter monoplanes were just commencing trials they were proposing a *twin*-engined shipboard fighter! Despite the revolutionary nature of its concept, the Skyrocket was ordered as a prototype by the U.S. Navy on June 30, 1938 under the designation XF5F-1.

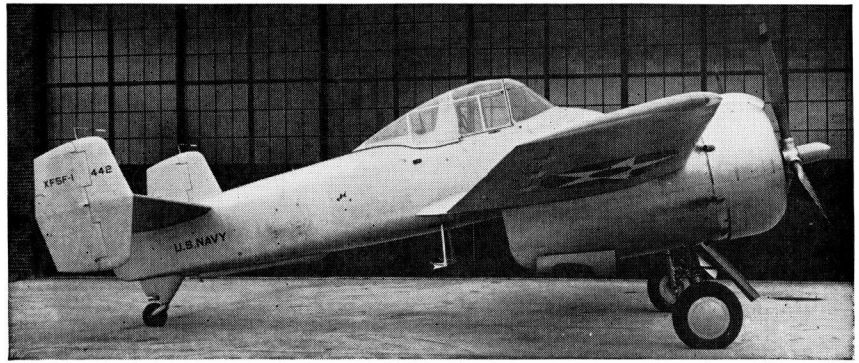


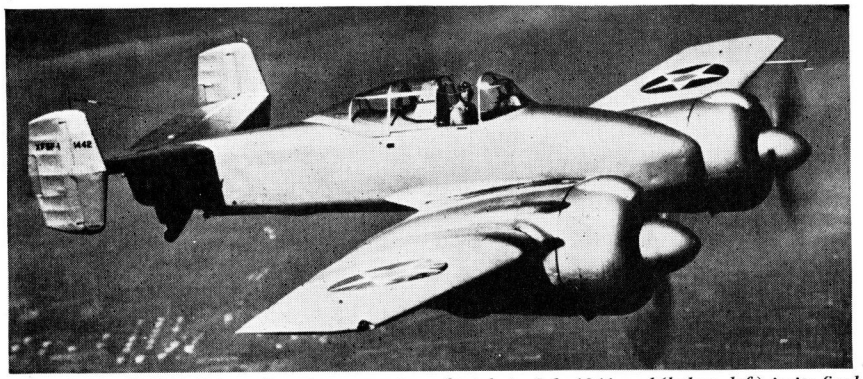
The XF5F-1 in its original form.

The XF5F-1 had a singular appearance owing to its abbreviated forward fuselage, the wing leading edge extending forward of the fighter's nose. Provision was made for the installation of two 23-mm. Madsen cannon, but no armament was mounted when the XF5F-1 was flown for the first time on April 1,

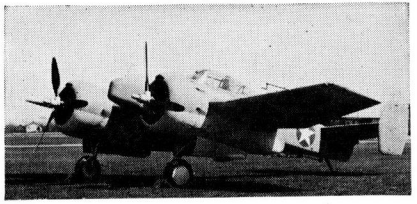


(Right) The XF5F-1 in July 1941 *after modifications and (below) as originally flown.*





(*Above*) *The XF5F-1 flying after the resumption of trials in July* 1941 *and* (*below, left*) *in its final form in April* 1943.



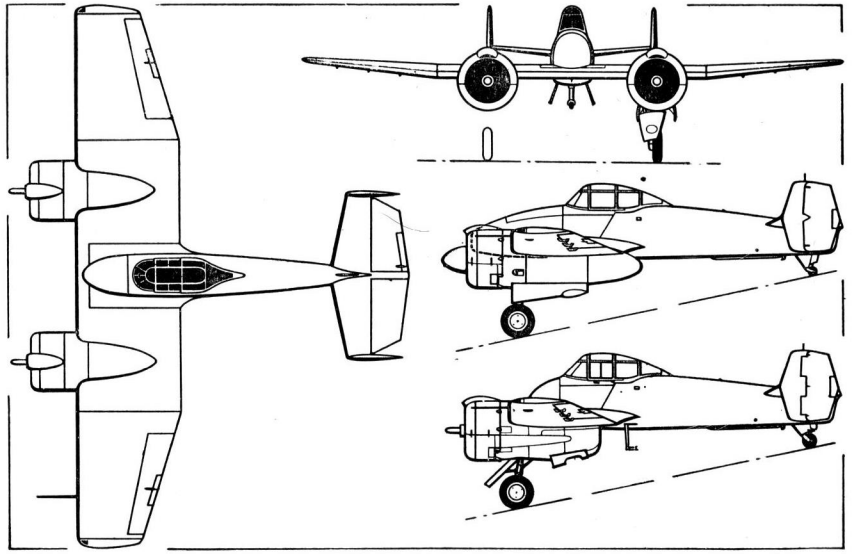
1940 by Grumman's test pilot B. A. Gilles. Cooling troubles immediately manifested themselves and, on June 1, modifications to the oil cooling ducts began, and owing to the subsequent delays the initial flight test programme was not completed until February 1941. As a result of this programme it was decided to make changes to the prototype and the modifications began on March 28, 1941 and were completed on July 15, 1941.

As early as July 31, 1940 the U.S. Navy had requested a reduction in the height of the cockpit enclosure and the installation of four 0.5-in. machine guns in place of the proposed Madsen cannon, and in addition to these changes, the engine nacelles were redesigned and extended aft to rectify continued cooling problems and poor airflow characteristics around the rear of the nacelles, spinners were added to the airscrew, and the fuselage nose was extended forward of the wing. Flight testing was resumed but further modifications were called for, these being initiated in October 1941 and completed on January 15, 1942. By this time Grumman were already working on a more advanced twin-engined shipboard fighter, the G-51, or XF7F-1, and testing of the XF5F-1 was continued to provide information for the development of the later type.

On February 3, 1942, the XF5F-1 was seriously damaged when its undercarriage was

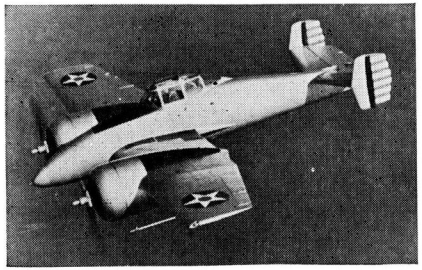
torn off during platform landings. Repairs were carried out but the aircraft was again damaged in a similar accident on May 18, 1942. After further repairs flight trials continued, but on June 13, 1944, the undercarriage collapsed while the XF5F-1 was parked at Annacostia. Undercarriage failure necessitated a belly landing at New York on December 11, 1944, and the aircraft was finally struck off the active list on the following day. During its test life, the XF5F-1 had made 211 flights and logged 155.7 hours in the air.

Type: *Single-seat Shipboard Interceptor.* **Power Plants:** *Two* 1,200 *h.p. Wright XR*-1820-40/42 *nine-cylinder radial air-cooled engines.* **Armament:** *Four* 0.5-*in. machine guns with* 400 *r.p.g. plus two* 165-*lb. bombs.* **Performance:** *Maximum speed,* 383 *m.p.h. at sea level,* 380 *m.p.h. at* 16,500 *ft.; range,* 1,200 *mls. at* 210 *m.p.h.; maximum climb rate,* 4,000 *ft./min.; service ceiling,* 33,000 *ft.; absolute ceiling,* 34,200 *ft.* **Weights:** *Empty,* 8,107 *lb.; loaded,* 10,138 *lb.* **Dimensions:** *Span,* 42 *ft.* 0 *in.; length,* 28 *ft.* 8½ *in.; height,* 11 *ft.* 4 *in.; wing area,* 303.5 *sq. ft.*



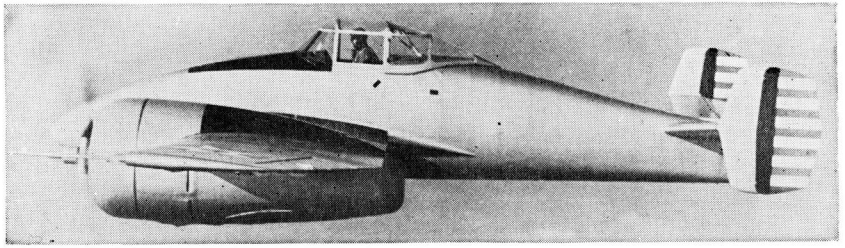
GRUMMAN XP-50 U.S.A.

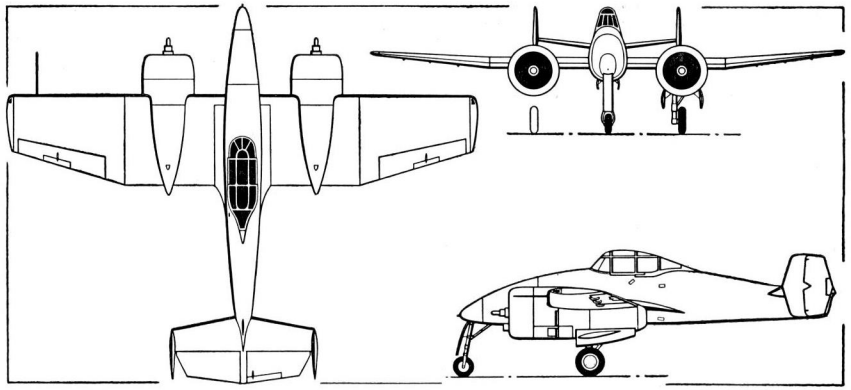
While Grumman were building the prototype shipboard XF5F-1 thought was given to the development of a land-based version and, as the G-46, this project was offered to the Army Air Corps in 1939, a prototype being ordered on November 25th of that year under the designation XP-50. The XP-50 was essentially similar to its shipboard counterpart but the fuselage nose was lengthened in order to provide a housing for a nosewheel, and provision was made for self-sealing fuel tanks and pilot armour.



Placed second to the XP-38 in the design competition for a twin-engined interceptor, the XP-50 was to have carried an armament of two 20-mm. cannon with 60 r.p.g. and two 0.5-in. machine guns with 500 r.p.g. The XP-50 was flown for the first time on May 14, 1941, but a turbo-supercharger explosion destroyed the aircraft during this initial flight. As at this time Grumman had started the design of a more advanced fighter, the G-51, incorporating much of the engineering experience gained with the XP-50 and its shipboard equivalent, the XF5F-1, the Army Air Corps decided to replace the XP-50 with the later design, and five days after the demise of the prototype, the procurement of two G-51s was recommended. The designation XP-65 was assigned to the type, and preliminary work incident to the study of the potentialities of the fighter was

(Above, left and below) The XP-50 seen during its one and only flight on May 14, 1941, which terminated in the aircraft's destruction when a turbo-supercharger exploded.





conducted under the same Expenditure Order covering the development of the XP-50.

The estimated performance of the XP-65 when equipped with two-stage engines was comparable with that anticipated for the XP-50 with turbo-supercharged engines. With turbo-superchargers the XP-65 was expected to have an appreciably higher performance than its naval equivalent, the XF7F-1, maximum speed being 431 m.p.h. at 27,000 ft., and initial climb rate and service ceiling being 4,400 ft./min. and 36,000 ft. respectively. However, Army Air Corps and Navy requirements conflicted in several respects, and it was decided that a fighter designed in accordance with the requirements of both services would have to carry such weight and performance penalties as to render it inferior to an aircraft designed specifically for one service. Thus, as Grumman was considered by the Navy to be one of its major production sources, development of the XF7F-1 was continued and that of the parallel XP-65 abandoned.

The following specification is based on manufacturers' estimates as the sole XP-50 was destroyed before performance trials could be conducted.

Type: *Single-seat Interceptor and Fighter-bomber.* **Power Plants:** *Two* 1,200 *h.p. Wright R-1820-67/69 nine-cylinder radial air-cooled engines.* **Armament:** (*Proposed*) *Two* 20-*mm. cannon with* 60 *r.p.g. and two* 0.5-in. *machine guns with* 500 *r.p.g., plus two* 100-*lb. bombs.* **Performance:** *Maximum speed,* 424 *m.p.h. at* 25,000 *ft.; range* (181 *Imp. gal.*), 585 *mls. at* 317 *m.p.h. at* 10,000 *ft.,* (375 *Imp. gal.*), 1,250 *mls.; time to* 20,000 *ft.,* 5 *min.; service ceiling,* 40,000 *ft.* **Weights:** *Empty,* 8,307 *lb.; normal loaded,* 10,558 *lb.; maximum,* 13,060 *lb.* **Dimensions:** *Span,* 42 *ft.* 0 *in.; length,* 31 *ft.* 11 *in.; height,* 12 *ft.* 0 *in.; wing area,* 304 *sq. ft.*

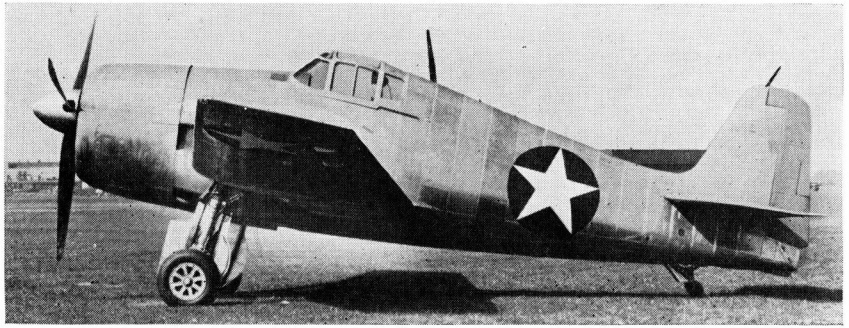
GRUMMAN F6F-3–F6F-5 HELLCAT U.S.A.

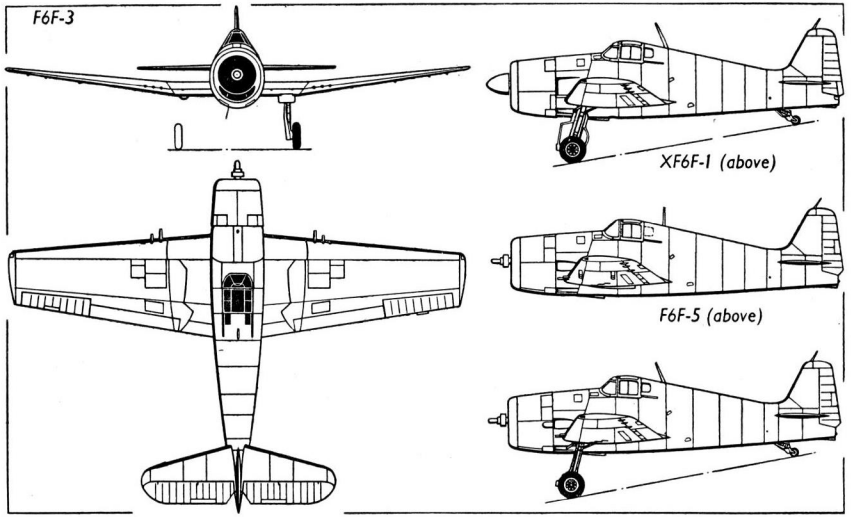
Shortly after the Japanese attack on Pearl Harbour, Grumman's design and engineering staffs began assessing the needs of U.S. Navy pilots in order to incorporate their requirements into the design of the XF6F-1 which had been ordered on June 30, 1941 as a potential successor to the Wildcat shipboard fighter. Powered by a 1,600 h.p. Wright R-2600 Cyclone, the XF6F-1 flew on June 26, 1942, but the modifications considered necessary in the light of operational experience during the opening stages of the Pacific War resulted in the designation of the second prototype being changed to XF6F-3 while still under construction, the XF6F-2 being a proposed version with a turbo-supercharged R-2600 engine.

The XF6F-3 was flown for the first time on July 30, 1942, with a Pratt and Whitney R-2800 Double Wasp. The speed with which Grumman attained production can be gauged from the fact that the first F6F-3 flew on October 4, 1942, ten Hellcats having been completed by the end of the year. The XF6F-3 was powered by an R-2800-10 Double Wasp developing 2,000 h.p. for take-off and 1,975 h.p. at 16,900 ft. Its normal loaded weight was 12,740 lb., and maximum speeds of 315 m.p.h. at sea level and 380 m.p.h. at 23,400 ft. were attained. Provision was made for an armament of six 0.5-in. wing-mounted guns with 400 r.p.g.

The production F6F-3 differed from the prototype in minor details only, the main undercarriage fairings being redesigned, the airscrew spinner being removed and a Hamilton Standard Hydromatic airscrew supplanting the Curtiss Electric unit. The first F6F-3s assigned to Fleet units were received by VF-9 on January 16, 1943 aboard the U.S.S. *Essex*, and the first use of the Hellcat in combat was made by VF-5 operating from the U.S.S. *Yorktown* during an attack on Marcus Island on August

The XF6F-3 (below) differed little from the initial production model of the Hellcat.

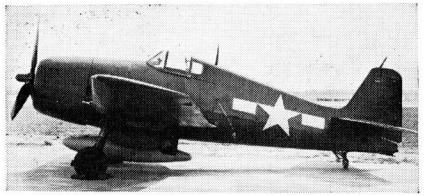


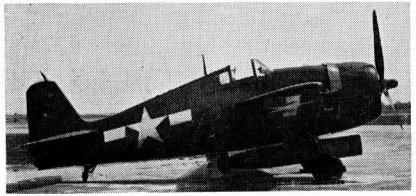


31, 1943—a mere eighteen months after the prototype's first flight! From this date, the Hellcat rapidly replaced the Wildcat on board the principal U.S. carriers and was destined to remain the standard fighter of the fast carrier force throughout the remainder of the war, the introduction of the Corsair to fast carrier operations in December 1944 supplementing rather than replacing the employment of the Grumman fighter in the final campaigns of the war.

The F6F-3 Hellcat, 2,545 examples of which were delivered during 1943, was similarly powered to the prototype, and 252 examples were supplied to Britain as the Hellcat I under Lend-Lease, first seeing service with the Fleet Air Arm in July 1943 with No. 800 Squadron which took the type onto operations from the light escort carrier *Emperor* in December during anti-shipping strikes off the Norwegian coast. The Hellcat's subsequent service with the Fleet Air Arm was primarily in the Far East. Night fighter variants were the F6F-3E with APS-4 radar and the F6F-3N with APS-6 housed in a pod beneath the starboard wing. Of the 4,423 F6F-3 Hellcats completed before production switched to the F6F-5 in April 1944, eighteen were F6F-3Es and 205 were F6F-3Ns.

The XF6F-2 had a turbo-supercharged





(*Above*) *An early production F6F-3.* (*Left*) *An F6F-3 experimentally fitted with two* 1,000-*lb. bombs and a* 137 *Imp. gal. drop tank and* (*below*) *with a dummy MK* 13-2 *torpedo.*

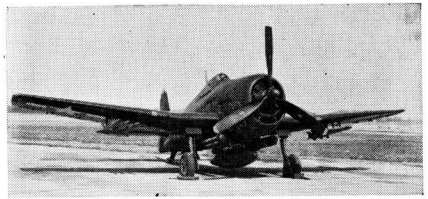
R-2800-21 engine installed in December 1943, flying with this in January 1944, and the airframe of the XF6F-1 was fitted with an R-2800-27 engine and flown on October 2, 1942 as the XF6F-4, but this model progressed no further than the prototype stage, the next production model of the Hellcat being the F6F-5 which flew for the first time on April 4, 1944. The F6F-5 differed from its predecessor in having a redesigned engine cowling, improved windshield, new ailerons, strengthened tail surfaces and additional armour behind the pilot, increasing total weight of armour from 212 to 242 lb. Two 1,000 -lb. bombs could be carried under the centre section, provision was made for six 5-in.

rocket projectiles, and late production models could have 20-mm. cannon in place of the two inner 0.5-in. machine guns. The power plant was an R-2800-10W similar to that installed in late production F6F-3s and capable of developing an emergency power of 2,200 h.p. by the use of water injection. No fewer than 6,436 F6F-5s had been produced when manufacture terminated in November 1945, approximately one-sixth of these being F6F-5N night fighters. Nine hundred and thirty F6F-5s were supplied to the Fleet Air Arm as Hellcat IIs, and a further eighty radar-equipped equivalents to the F6F-5N were delivered to the U.K. Two F.A.A. squadrons were formed with Hellcat N.F.IIs, Nos. 891 and 892, but neither saw operational service. Ten other F.A.A. squadrons were operating Hellcat Is and IIs on V-J Day, mostly in the Far East.

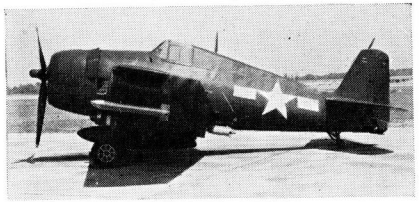
One other version of the Hellcat was built, the XF6F-6 powered by the 2,100 h.p. R-2800-18W engine. The first of two examples of the XF6F-6 was flown on July 6, 1944, but no production was undertaken. A total of 12,274 Hellcats of all types was produced, and this fighter was credited with 4,947 of the 6,477 enemy aircraft destroyed in the air by U.S. Navy carrier pilots. With the scores of shore-based Hellcat units, including U.S. Marine Corps squadrons, added, this one fighter type was responsible for the destruction of no less than 5,156 enemy aircraft.

The specification relates to the F6F-3, figures in parentheses relating to the F6F-5.

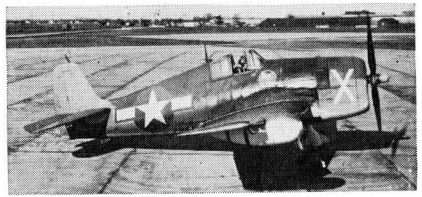
Type: *Single-seat Shipboard Fighter* (*-bomber*). **Power Plant:** *One* 2,000 *h.p. Pratt and Whitney R-*2800-10 (-10W) *eighteen-cylinder radial air-cooled engine.* **Armament:** *Six* 0.5-*in. machine guns with* 400 *r.p.g.* (*plus two* 1,000-*lb. bombs or six* 5-*in. rockets*). **Performance:** *Maximum speed,* 335 *m.p.h. at sea level,* 376 (386) *m.p.h. at* 17,300 *ft.; normal range,* 1,090 (1,040) *mls. at* 160 (159) *m.p.h.,* (*with* 125 *Imp. gal. drop tank*), 1,590 (1,530) *mls.; initial climb rate,* 3,500 (3,410) *ft./min.; service ceiling,* 38,400 (37,300) *ft.* **Weights:** *Empty,* 9,042 (9,153) *lb.; normal loaded,* 11,381 (12,500) *lb.* **Dimensions:** *Span,* 42 *ft.* 10 *in.; length,* 33 *ft.* 7 *in.; height,* 13 *ft.* 1 *in.; wing area,* 334 *sq. ft.*



(*Above and immediately below*) *An F6F-5 with two* 11.75-*in. rockets, six* 5-*in. rockets and a* 125 *Imp. gal. drop tank.*



(*Below*) *The XF6F-3N night fighter prototype.*

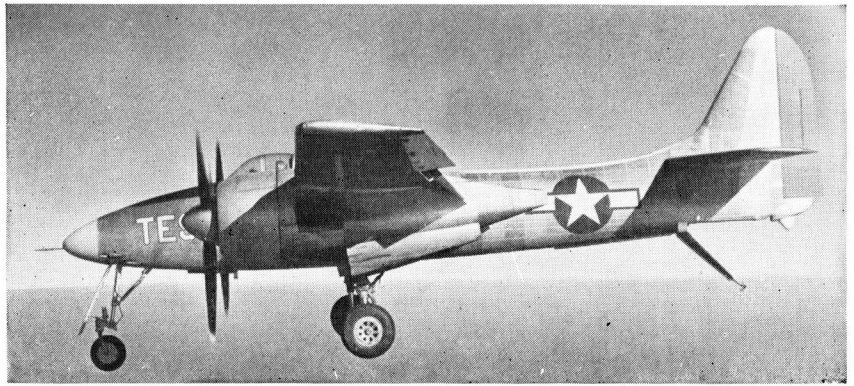


GRUMMAN F7F-1–F7F-3 TIGERCAT — U.S.A.

The first twin-engined shipboard aircraft to enter production and the first fighter with a nosewheel undercarriage to operate successfully aboard carriers, the Grumman G-51 Tigercat was designed primarily for service aboard the future 45,000-ton *Midway*-class carriers, and owed much to experience gained with the G-34 Skyrocket, or XF5F-1. Conceived early in 1941, the G-51 bore little resemblance to the earlier shipboard twin-engined fighter. Two prototypes were ordered on June 30, 1941 under the designation XF7F-1, the first of these flying in December 1943.

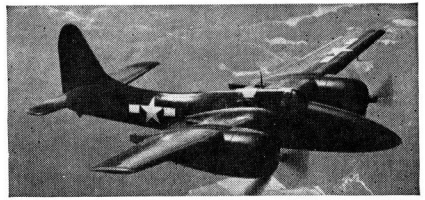
A cantilever shoulder-wing single-seater, the XF7F-1 was powered by a pair of 2,100 h.p. R-2800-22W Double Wasp engines, and carried what was for that time the phenomenal armament of four 20-mm. cannon with 200 r.p.g. in the wing roots and four 0.5-in. guns with 300 r.p.g. in the fuselage nose. A standard torpedo could be carried beneath the fuselage and provision was made for two 1,000-lb. bombs under the inner wings. Five hundred production machines had been ordered to equip shore-based U.S. Marine Corps squadrons in 1943, and the first production

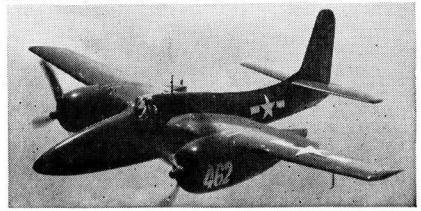
(*Below*) *The first XF7F-1 and* (*left*) *the second XF7F-1.*

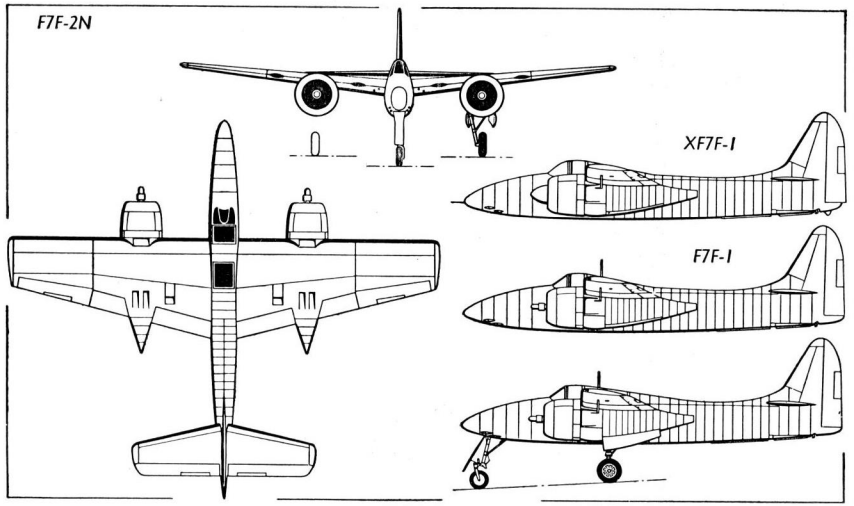


(*Above*) *The fourth production F7F-1.* (*Immediately below*) *The F7F-2 and* (*bottom*) *the F7F-3.*

F7F-1 Tigercat appeared in April 1944. This was generally similar to the prototypes and, like the following thirty-three aircraft, was a single-seater. However, the thirty-fifth production machine was completed as a two-seater and designated F7F-2N. Internal fuel capacity was reduced from 355 Imp. gal. to 312 Imp. gal. to provide space aft of the pilot for a radar-operator, and the nose-mounted battery of machine guns was deleted. The first two-seater was designated XF7F-2N, and was followed in 1944 by a further thirty F7F-2N two-seaters. Thirty-four machines produced by March 1945 completed production of this model which was supplanted by a further single-seat version, the F7F-3. This was essentially similar to the original F7F-1, mounting the same armament, but had R-2800-34W engines offering 1,850 h.p. at 15,500 ft. as compared with the -22W model's 1,600 h.p., and a slight increase in internal fuel tankage to 379 Imp. gal.







The Tigercat was too late to see operational service with Marine Corps squadrons, and post V-J Day cancellations restricted production of the F7F-3 to 189 machines. A post-war development was the F7F-3N two-seat night fighter, sixty examples of which were produced in 1946, and production terminated with thirteen F7F-4N two-seaters which featured a redesigned radar nose, these being the only models of the Tigercat actually equipped for shipboard operations.

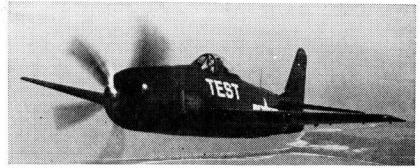
The following specification relates to the two-seat F7F-2N, figures in parentheses relating to the single-seat F7F-3 Tigercat, the last wartime production version of the fighter.

Type: *Two- (single-) seat Night (Day) Fighter.* **Power Plants:** *Two* 2,100 *h.p. Pratt and Whitney R-2800-22W (-34W) eighteen-cylinder radial air-cooled engines.* **Armament:** *Four* 20-*mm. cannon with* 200 *r.p.g. (and four* 0.5-*in. machine guns with* 300 *r.p.g.).* **Performance:** *Maximum speed,* 362 (367) *m.p.h. at sea level,* 421 (435) *m.p.h. at* 20,600 (22,200) *ft.; initial climb rate,* 4,540 (4,530) *ft./min.; service ceiling,* 39,800 (40,700) *ft.; normal range,* 960 (1,200) *mls.; maximum range,* 1,250 (1,572) *mls.* **Weights:** *Empty,* 16,321 (16,270) *lb.; normal loaded,* 21,857 (21,720) *lb.; maximum,* 26,194 (25,720) *lb.* **Dimensions:** *Span,* 51 *ft.* 6 *in.; length,* 45 *ft.* 4½ *in.; height,* 16 *ft.* 7 *in.; wing area,* 455 *sq. ft.*

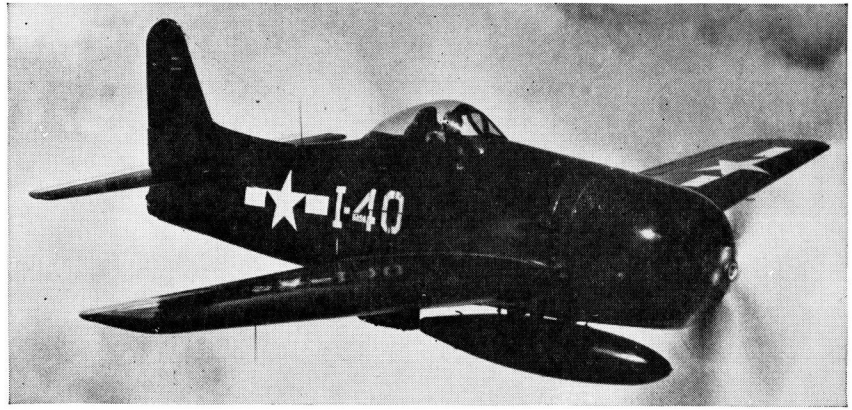
GRUMMAN F8F-1 BEARCAT — U.S.A.

The last of the long line of piston-engined Grumman shipboard fighters, the Bearcat was designed to operate from carriers of all sizes. Accent was on low-altitude performance, climb rate and manoeuvrability, and the extraordinary rapidity with which this fighter was designed and placed in quantity production even eclipsed that of its immediate predecessor, the Hellcat, the first prototype Bearcat flying within ten months of the development contract being placed, with production deliveries commencing five months later!

Two prototypes of the Bearcat, designated XF8F-1, were ordered on November 27, 1943, and the first of these flew on August 21, 1944. Retaining the distinctive, portly lines that had characterised all earlier Grumman single-engined fighters, the XF8F-1 was appreciably smaller than the Hellcat and was, in fact, what the Grumman design team considered to be the smallest fighter that could be designed around the Double Wasp engine and the specified fuel tankage, armament and armour protection. A weak point was built into each



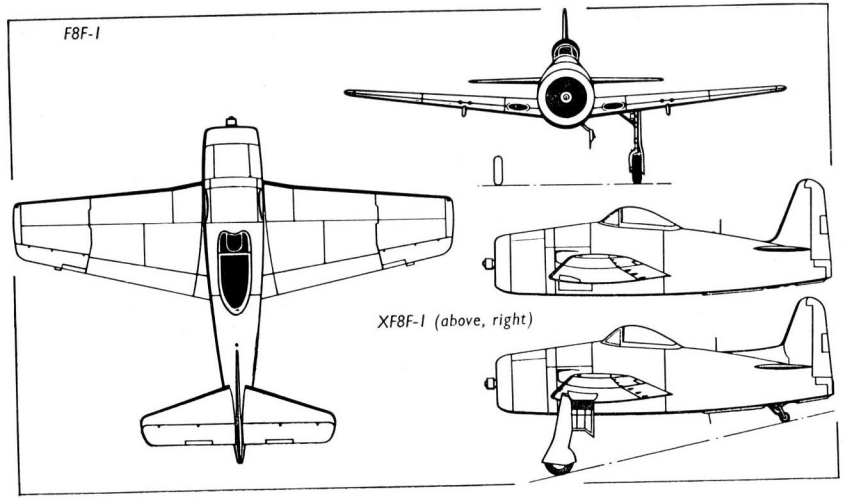
(*Above, right*) *The XF8F-1 first flown on August* 21, 1944, *and* (*below*) *an F8F-1 Bearcat.*



of the outer wing panels so that if the wings were overstressed in flight, the tips would break off, an explosive charge ensuring that both tips broke away. This feature was eventually eliminated. The XF8F-1 was powered by an R-2800-22W engine rated at 2,100 h.p. for take-off and 1,600 h.p. at 16,000 ft. Internal fuel tankage had a total capacity of 125 Imp. gal., and at a gross weight of 8,788 lb., the prototype attained maximum speeds of 393 m.p.h. at sea level and 424 m.p.h. at 17,300 ft., initial climb rate being 4,800 ft./min.

Shortly after the test programme began, contracts for 2,023 F8F-1 Bearcats were approved, deliveries commencing in February 1945. The F8F-1 differed from the XF8F-1 in few respects; a small dorsal fin was added, an R-2800-34W engine was installed, and internal fuel capacity was increased to 154 Imp. gal. Armament comprised four 0.5-in. guns with 300 r.p.g., and 169 lb. of armour was fitted. The first U.S. Navy squadrons to re-equip with the F8F-1 were working up on V-J Day, and were thus too late to see combat service, and the end of fighting resulted in drastic reductions

Deliveries of the F8F-1 to the U.S. Navy began on May 21, 1945, the first unit being VF-19.



in contracts for the Bearcat, the order placed with General Motors' Eastern Aircraft Division on February 5, 1945 for 1,876 Bearcats to be designated F3M-1 being cancelled completely. Two hundred and eight Bearcats had been delivered by the end of 1945, and Grumman went on to produce a further 1,058 machines, including 100 examples of the purely post-war F8F-1B with four 20-mm. cannon, thirty-six F8F-1N night fighters, 293 F8F-2s with redesigned engine cowling and modified vertical tail surfaces, twelve F8F-2N night fighters, and sixty F8F-2P reconnaissance fighters. The Bearcat enjoyed an exceptional performance, and for a period held the world record for the fastest climb to 10,000 ft.

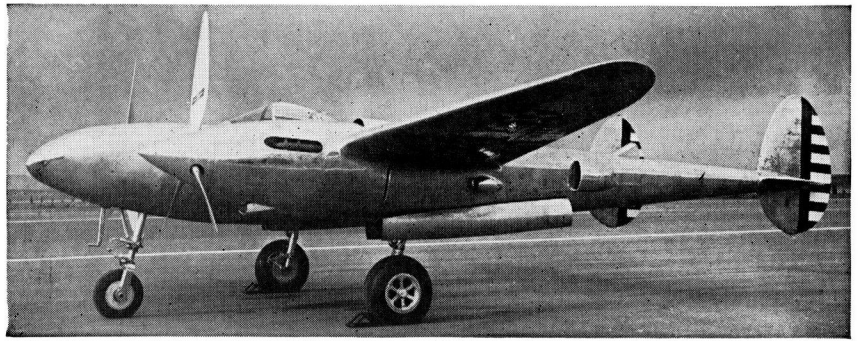
Type: *Single-seat Shipboard Interceptor and Fighter-bomber.* **Power Plant:** *One* 2,100 *h.p. Pratt and Whitney R-2800-34W eighteen-cylinder radial air-cooled engine.* **Armament:** *Four* 0.5*-in. machine guns with* 300 *r.p.g. plus two* 1,000*-lb. bombs or four* 5*-in. rockets.* **Performance:** *Maximum speed,* 382 *m.p.h. at sea level,* 421 *m.p.h. at* 19,700 *ft.; economical cruising speed,* 163 *m.p.h.; range (internal fuel),* 1,105 *mls., (with two* 125 *Imp. gal. drop tanks),* 1,965 *mls.; initial climb rate,* 4,570 *ft./min.; service ceiling,* 38,700 *ft.* **Weights:** *Empty,* 7,070 *lb.; normal loaded,* 9,836 *lb.; maximum,* 12,947 *lb.* **Dimensions:** *Span,* 35 *ft.* 10 *in.; length,* 28 *ft.* 3 *in.; height,* 13 *ft.* 10 *in.; wing area,* 244 *sq. ft.*

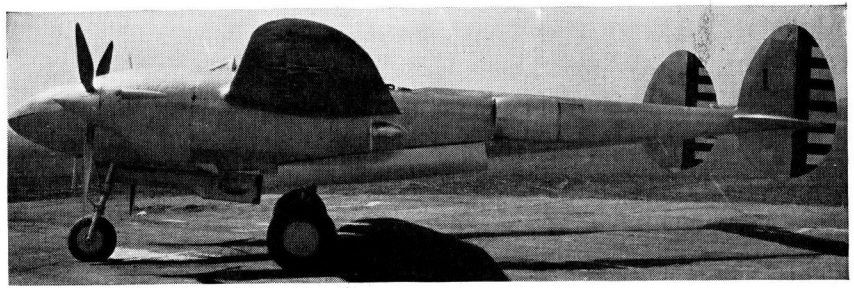
LOCKHEED P-38–P-38G LIGHTNING U.S.A.

During the late 'thirties several countries were developing or testing twin-engined single-seat fighters but undoubtedly the most interesting of these for the number and variety of its innovations was Lockheed's Lightning produced by a team headed by H. L. Hibbard. Eventually to become the first squadron fighter equipped with turbo-superchargers, and the U.S.A.A.F.'s first twin-engined single-seater and first aircraft of twin-boom configuration, the Lightning began life as the Lockheed Model 22 and was designed to meet an Army Air Corps specification for a high-altitude high-speed interceptor. As no engine available at the time the specification was issued was capable of giving sufficient power to meet the required performance, the design team decided to adopt a twin-engined layout and, after considering six possible arrangements, the radical twin-boom configuration was selected. The booms provided convenient mountings for the turbo-superchargers, as well as the engines, radiator baths, and main undercarriage members, while the twin fin-and-rudder tail assembly increased the effective aspect ratio of the tailplane by endplate effect, providing stability over a large c.g. range.

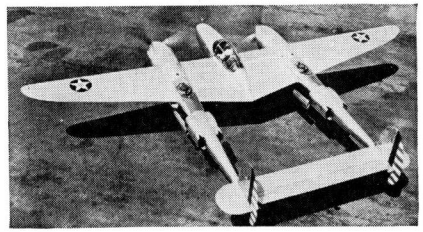
Detail drawings of the Model 22 were submitted in the spring of 1937, and in June a prototype was ordered as the XP-38. Provision was made for the exceptionally heavy armament of four 23-mm. Madsen cannon with 50 r.p.g. and four 0.5-in. Colt-Browning MG 53 machine guns with 1,000 r.p.g. in the central nacelle, and the torque of the Allison V-1710-11/15 (C9) engines, which developed 1,090 h.p. at 13,200 ft., was compensated by inwardly-rotating handed Curtiss Electric airscrews, a special version of the Allison engine being produced with a left-hand rotating airscrew shaft. Ground runs began at the beginning of January 1939, and the XP-38 flew for the first

The XP-38 which began trials on January 27, 1939, but was destroyed fifteen days later.





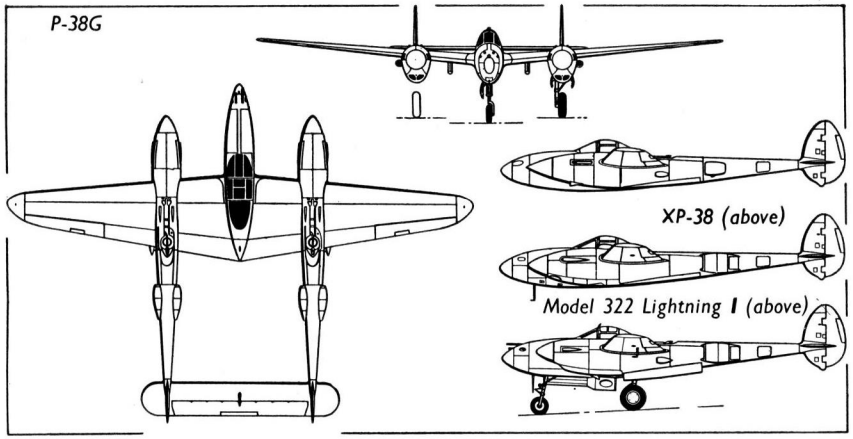
(*Above and right*) *The first YP-38 Lightning.*



time on the 27th of that month. On April 27, 1939, thirteen YP-38s were ordered for service evaluation, and on August 10th sixty-six production machines were also ordered.

The YP-38s (Model 122s) were redesigned for production and included the installation of V-1710-27/29 (F2) engines rated at 1,150 h.p. for take-off with spur reduction gearing instead of the former epicyclic type. The airscrews became outwardly-rotating, and the thrust line was raised, the lip intake being replaced by two coolant segments. Armament specified for the YP-38 comprised one 37-mm. cannon, two 0.5-in. and two 0.3-in. machine guns, and before the first of these test aircraft had flown on September 16, 1940, large-scale production orders had been received. The British Air Purchasing Commission placed an order for 667 examples of an export version, the Model 322, on June 5, 1940, and in September the Army Air Corps' order for sixty-six Model 222s was supplemented by an order for a further 607 aircraft.

The YP-38 attained a maximum speed of 405 m.p.h. at 20,000 ft., climbing to that altitude in six minutes, and empty and normal loaded weights were 11,171 lb. and 13,500 lb., while maximum loaded weight was 14,348 lb., these figures being somewhat lower than those for the overweight XP-38 as a result of structural redesign, but production was extremely slow in building up tempo, and the thirteen YP-38s were not all completed until June 1941, although the first batch of thirty production P-38s was following closely on their heels. The P-38 was similarly powered to the YP-38 but some armour protection had been introduced for the pilot, and nose armament had been changed to one 37-mm. cannon and four 0.5-in.

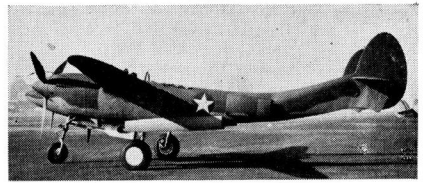


guns. Early flight testing revealed a certain amount of tail buffeting, and one of the P-38s was fitted with upswept booms designed to raise the tailplane out of the wing wake which was believed to be responsible for the buffeting. The experiment was unsuccessful, however, and the aircraft was destroyed during flight trials. The solution to the problem was a change in tailplane incidence, together with a redistribution of elevator mass balances, thus increasing the mechanical advantage of the elevator control, eliminating the buffeting and facilitating dive recovery. These changes were embodied in the last thirty-six machines of the original order of August 10, 1939, the aircraft being designated P-38D Lightnings.

The XP-38A (Model 622) was a production P-38 fitted with an experimental pressure cabin, and the P-38B and P-38C were undeveloped projects. Apart from the previously-mentioned changes, the P-38D embodied the requirements indicated by combat reports from Europe, including self-sealing fuel tanks, and was, therefore, the first really combat-worthy version of the Lightning. From the old high-pressure oxygen system the P-38D changed to a low-pressure system, standard on all subsequent models, a retractable landing light was fitted, and provision was made for flares. The first P-38D Lightnings reached the A.A.F. in August 1941, the thirty-six aircraft of this type being followed in October by the first P-38Es which embodied a major armament change, the 37-mm. cannon being supplanted by one of 20-mm. calibre. This model also featured a redesigned nose section with double

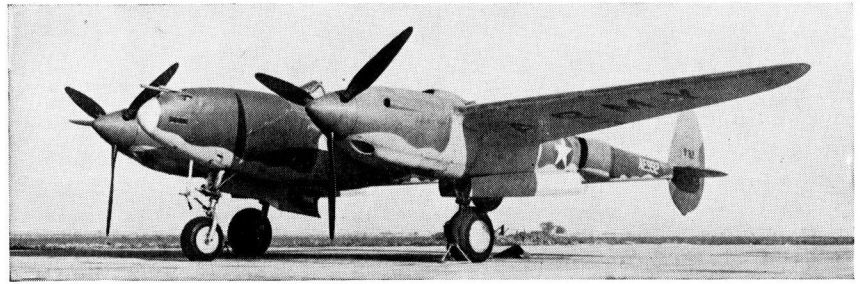
the ammunition capacity of earlier machines, and revised hydraulic and electric systems. Ninety-nine of the 210 P-38E Lightnings built were converted as F-4 photo-reconnaissance aircraft before completion, deliveries to the A.A.F. commencing in March 1942. The F-4 differed from the P-38E in that the nose armament was supplanted by four K-17 cameras.

Chronologically, the Model 322 for the R.A.F. was the next version of the Lightning to be produced, production paralleling that of the A.A.F.'s P-38E to which it was generally similar, the first production Lightning I, as the British model was designated, flying in December 1941. The first 143 aircraft of the British contract were Model 322-61s which, dubbed "castrated P-38s" by the factory, had the turbo-superchargers and the opposite-rotating airscrews removed, and two of the early V-1710-C15 (R) engines rated at 1,040 h.p. at 15,000 ft., the "R" suffix indicating right-hand rotation of both airscrew shafts. For some unexplained reason, the British Air Purchasing Commission had requested these



(Above) An early attempt to eliminate tail buffeting on a modified P-38 and (below) the XP-38A, a production P-38 fitted with an experimental pressure cabin.

The fifteenth production Model 322-61 in service with the A.A.F. but retaining British serial AE992. Originally built to R.A.F. requirements, the Model 322-61 was turned down after evaluation at Boscombe Down.



modifications despite predictions by Lockheed engineers that performance would be much inferior to the standard A.A.F. model. Two Model 322-61s were tested at Boscombe Down in April–June 1942, but performance was so disappointing that machines shipped to the United Kingdom were returned, and the remainder of the order was cancelled. A.A.F. pilots found that the Model 322-61 was nose-heavy and unable to maintain formation with standard P-38Es above 12,000 ft., and aircraft of this type were, therefore, sent to a modification centre at Dallas, Texas, and subsequently served as trainers and for various experimental purposes under the designation P-322. The last 524 aircraft on the British contract were to have been Model 322-60 Lightning IIs with standard turbo-supercharged Allisons, but these were absorbed into A.A.F. contracts, 150 as P-38F-13-LO and -15-LO Lightnings and the remainder as P-38G-15-LOs.

An Iceland-based Lightning shot down an Fw 200 Condor over the Atlantic in August 1942 to draw first blood for the aircraft, the model involved being the P-38F, which had appeared in February 1942. This model had V-1710-49/53 (F5) engines rated at 1,225 h.p. at take-off and 1,150 h.p. at 25,000 ft., and the P-38F-1-LO was the first version of the Lightning to have racks under the inner wings for two 62.5 or 125 Imp. gal. drop tanks or 1,000-lb. bombs. Each rack could also carry a Smoke Curtain Installation or a 22-in. torpedo. The P-38F--5-LO introduced A-12 oxygen equipment, while the P-38F-13-LOs were machines taken over from the British contract and had modified instruments meeting British Approved Specification No. 2338. In order to improve manoeuvrability the P-38F-15-LO introduced a combat setting of 8° to the flaps for rapid extension to tighten turns by increasing the CL. In all, 527 P-38F Lightnings were built and of these twenty were converted as F-4A photo-reconnaissance aircraft while a small number of others had their radio equipment removed and a crude seat installed over the main spar on which a pupil pilot was seated, becoming familiar with the Lightning's flight characteristics from this vantage point.

P-38F Lightnings took part in their first large-scale operations during the North African campaign, in November 1942, where mixed success was encountered. Enemy tactics frequently forced the Lightnings down from their rated altitude to fight at heights of the order of 15,000 ft. The twin engines restricted manoeuvrability to some extent, and the Lightning was not, therefore, entirely successful in fighter-versus-fighter combat. Nevertheless, it proved an extremely effective bomber destroyer with a sensational zoom climb, and it wreaked havoc among Rommel's air transport well out to sea.

The next production model, the P-38G, which began to appear in June 1942, was similar to its predecessor apart from the change to V-1710-51/55 (F10) with increased boost ratings and offering 1,325 h.p. for take-off but limited to 1,150 h.p. at 27,000 ft. owing to inadequate cooling, and the installation of SCR-274N radio and A-9 oxygen equipment. Superchargers of B-13 type were installed on the P-38G-3-LO, and the P-38G-5-LO also had revised supercharger equipment and resistance instruments.

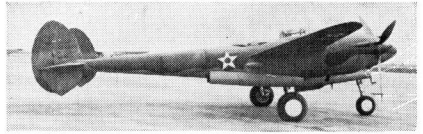
One thousand and eighty-two P-38G Lightnings had been delivered by March 1943, 181 of these being completed as F-5A photo-reconnaissance aircraft, and another 200 with intercoolers as F-5Bs.

During the summer of 1942, the 1st and 14th Fighter Groups equipped with the P-38F and G Lightning began to arrive in the United Kingdom, ferrying their aircraft across the

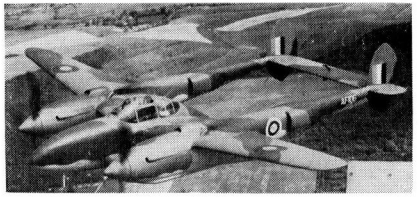
(*Above*) *A P-38F Lightning on Guadalcanal in February* 1943 *and* (*below, right*) *a P-38D.*

Atlantic because of the premium on trans-atlantic shipping space. Early in 1943, fifty Lightnings flew the South Atlantic to North Africa, and with the arrival of other aircraft in the South-West Pacific, the fighter was literally in world-wide service.

The following specification relates to the P-38F-15-LO, figures in parentheses relating to the P-38G-1-LO.



(*Below*) *One of the Model* 322-61*s tested in U.K.*



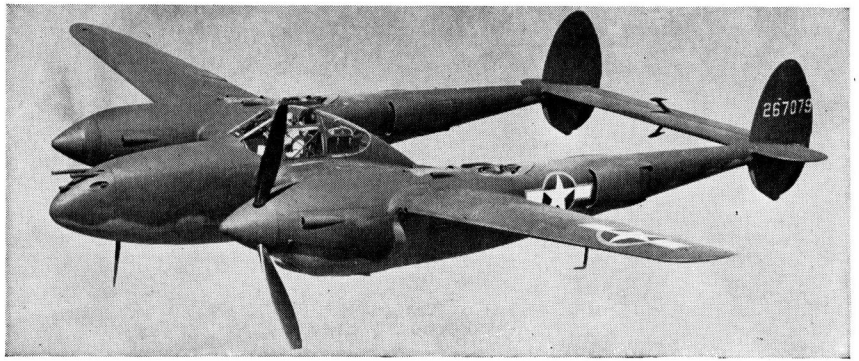
Type: *Single-seat Long-range Fighter and Fighter-bomber.* **Power Plants:** *Two* 1,225 (1,325) *Allison V*-1710-49/53 (-51/55) *twelve-cylinder Vee liquid-cooled engines.* **Armament:** *One* 20-*mm. Hispano M*1 *cannon with* 150 *rounds and four* 0.5-*in. Colt-Browning MG* 53-2 *machine guns with* 500 *r.p.g. plus two* 325, 500, *or* 1,000-*lb. bombs.* **Performance:** *Maximum speed,* 347 (345) *m.p.h. at* 5,000 *ft.,* 351 (360) *m.p.h. at* 10,000 *ft.,* 395 (400) *m.p.h. at* 25,000 *ft.; range on internal fuel,* 400 (350) *mls. at* 333 (350) *m.p.h. at* 25,000 *ft.,* 900 (850) *mls. at* 219 (219) *m.p.h. at* 10,000 *ft.,* (*with two* 125 *Imp. gal. drop tanks*), 850 (750) *mls. at* 327 (341) *m.p.h. at* 25,000 *ft.,* 1,750 (1,670) *mls. at* 213 (211) *m.p.h. at* 10,000 *ft.; time to* 10,000 *ft.,* 4 (3.7) *min., to* 20,000 *ft.,* 8.8 (8.5) *min.; service ceiling,* 39,000 *ft.* **Weights:** *Empty,* 12,264 (12,200) *lb.; normal loaded,* 15,900 (15,800) *lb.; maximum,* 19,900 (19,800) *lb.* **Dimensions:** *Span,* 52 *ft.* 0 *in.; length,* 37 *ft.* 10 *in.; height,* 9 *ft.* 10 *in.; wing area,* 327.5 *sq. ft.*

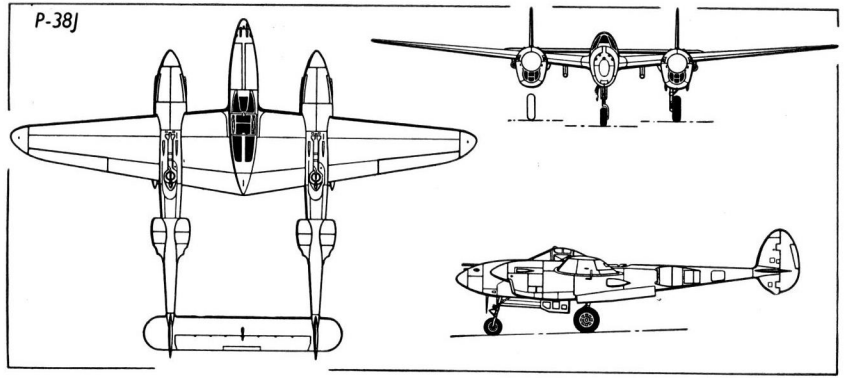
LOCKHEED P-38H–P-38M LIGHTNING — U.S.A.

With the availability of the F15 version of the Allison engine, a new model of the Lightning was introduced on the production line, the P-38H, the first pre-production model of which was tested in September 1942 with production deliveries beginning during the following March. The principal differences between the P-38H-1-LO and the last two hundred P-38G-10-LO Lightnings were the introduction of V-1710-89/91 engines offering 1,425 h.p. for take-off but limited to 1,240 h.p. at 25,000 ft. owing to inadequate cooling despite the introduction of automatically operated oil radiator flaps, and an M2C cannon in place of the M1 of similar calibre. The increase to 1,600-lb. bomb capacity, for which underwing racks introduced on the last two hundred P-38G-10-LO Lightnings, was also a feature of the P-38H. The P-38H-5-LO had B-33-type turbo-superchargers giving improved altitude performance, and 601 P-38H models were produced, of which 128 were completed as F-5C photo-reconnaissance aircraft.

Throughout the Lightning's production life its external contours had remained virtually unchanged until, in August 1943, the P-38J began to appear. Known by the manufacturers as the Model 422, the P-38J-1-LO introduced a beard radiator under each drive shaft, resulting from the sandwiching of the inter-cooler air intake between the oil radiator intakes. The price paid for this modification was a slight increase in drag, but this was more than compensated for by the improved cooling effect enabling the V-1710-89/91 to develop its full 1,425 h.p. at 26,500 ft., and with a maximum speed of 420 m.p.h. at that altitude, the P-38J was the fastest variant of the entire Lightning

The P-38H-5-LO Lightning (42-67079). *Deliveries of the H-model began in March* 1943.



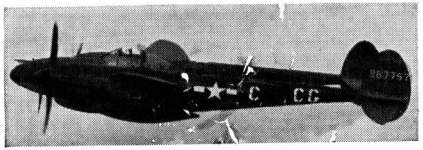


series. However, the wing instability problems first experienced during wind tunnel tests in 1938 now reappeared. Careful filleting of the wing-fuselage junction eventually overcame these difficulties.

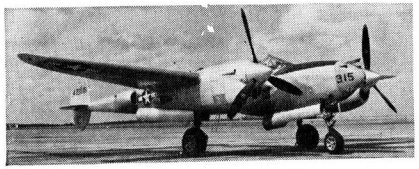
From the P-38J-5-LO production batch, the leading-edge space formerly occupied by the intercooler was occupied by two 46 Imp. gal. fuel tanks, increasing total internal fuel capacity to 341 Imp gal. To counteract a strong nose-down pitching moment at high speed in this model of the Lightning, a small electrically-operated dive flap was introduced under each wing, commencing with the P-38J-25-LO production batch. To increase manoeuvrability, this batch also introduced a power-boosting system on the ailerons which, consisting of hydraulically-operated bell-cranks and push-pull rods, was one of the first applications of powered controls to any fighter. One P-38J was experimentally fitted with Allison V-1710-75/77 engines with larger airscrews as the XP-38K, and 2,970 J-Model Lightnings were produced, several hundred of these being converted as F-5Es and F-5Fs.

By the spring of 1944 there were thirteen A.A.F. operational Lightning groups in overseas service, mostly equipped with the P-38J. Three of these groups were in the South-West Pacific area, where the Lightning was to claim more Japanese aircraft destroyed than any other fighter, and the leading American fighter ace of the Second World War, Major Richard Bong, scored all forty of his victories while flying Lightnings in this area. In Europe, serving principally with the tactical 9th Air Force, the Lightnings operated on long-range fighter escort and ground attack duties, mounting the first bomber escort missions to Berlin.

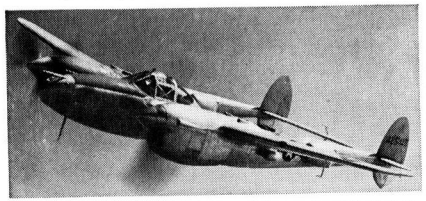
Some P-38J Lightnings were modified in Europe by having the standard nose replaced by an extra crew position with a transparent bomb-aiming nose and Norden bomb sight.



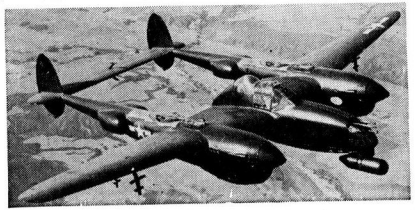
(*Above*) P-38J-10-LO. (*Below*) P-38J-20-LO.



(*Below*) *A P-38L-5-LO Lightning.*



(*Below*) *A P-38M converted from P-38L-5-LO.*

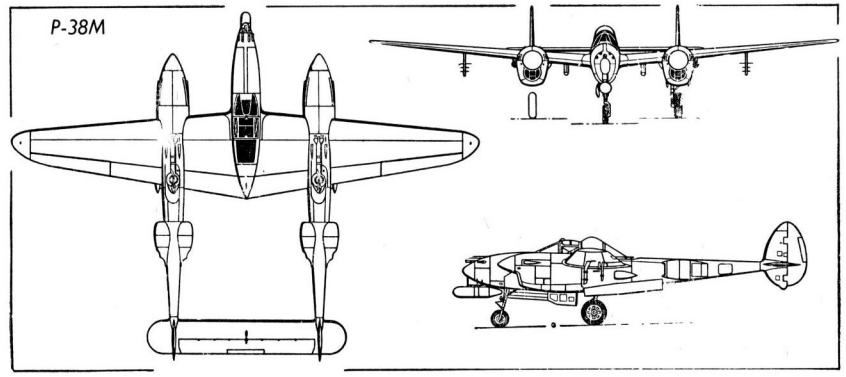


Dubbed "droop-snoot" Lightnings, these were used to lead formations of P-38s each carrying two 2,000-lb. bombs which were released on instructions from the lead bombardier. Other Lightnings had the visual bomb-aiming position replaced by B.T.O. radar which enabled attacks to be delivered even when the target was obscured by cloud.

Some of the aircraft so modified were P-38Ls, this model having begun to appear in June 1944. The P-38L Lightning was generally similar to its predecessor but had V-1710-111/113 (F30) engines offering 1,475 h.p. for take-off, and possessing a war emergency rating of 1,600 h.p. at 26,500 ft. The P-38L-5-LO saw the introduction of underwing rocket "trees" for ten 5-in. projectiles, and 3,810 P-38Ls were produced by Lockheed at Burbank, and a further 113 P-38L-5-VN Lightnings were delivered by Consolidated-Vultee's Nashville factory, V-J Day resulting in the cancellation of an additional 1,887 machines from this plant.

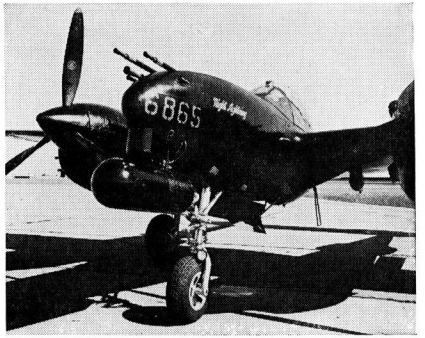
Many P-38Ls were completed as F-5E and F-5G photo-reconnaissance aircraft, and seventy-five were converted as P-38M night fighters. The P-38M carried all the normal armament load, a radar operator was seated behind and slightly above the pilot, and ASH-type radar was mounted under the nose. This improvisation resulted in an effective night fighter with very little performance penalty over the standard single-seater, maximum speed being 406 m.p.h. at 15,000 ft. and 361 m.p.h. at 5,000 ft., initial climb rate being 3,075 ft./min., and an altitude of 20,000 ft. being attained in 8.7 minutes. The P-38M saw operational service in the Pacific during the last days of the fighting.

The following specification relates to the P-38J-25-LO, the last version of the Lightning to be built in large quantities. Performance of the P-38J was generally similar.



Type: *Single-seat Long-range Fighter and Fighter-bomber.* **Power Plants:** *Two* 1,425 *h.p. Allison V-*1710-89/91 *twelve-cylinder Vee liquid-cooled engines.* **Armament:** *One* 20-*mm. Hispano M*2(*C*) *cannon with* 150 *rounds and four* 0.5-*in. Colt-Browning MG* 53-2 *machine guns with* 500 *r.p.g. plus two* 500, 1,000 *or* 1,600-*lb. bombs* (*or ten* 5-*in. rockets*). **Performance:** *Maximum speed,* 360 *m.p.h. at* 5,000 *ft.,* 390 *m.p.h. at* 15,000 *ft.,* 414 *m.p.h. at* 25,000 *ft.; range* (*internal fuel*), 475 *mls. at* 339 *m.p.h. at* 25,000 *ft.,* 800 *mls. at* 285 *m.p.h. at* 10,000 *ft.,* 1,175 *mls. at* 195 *m.p.h. at* 10,000 *ft.,* (*with two* 250 *Imp. gal. drop tanks*), 2,260 *mls. at* 186 *m.p.h. at* 10,000 *ft.; climb to* 5,000 *ft.,* 2 *min., to* 15,000 *ft.,* 5 *min., to* 20,000 *ft.,* 7 *min.; service ceiling,* 44,000 *ft.* **Weights:** 12,780 *lb.; normal loaded,* 17,500 *lb.; maximum,* 21,600 *lb.* **Dimensions:** *Span,* 52 *ft.* 0 *in.; length,* 37 *ft.* 10 *in.; height,* 9 *ft.* 10 *in.; wing area,* 327.5 *sq. ft.*

The P-38M night fighter saw service in the Pacific during the last days of the war.



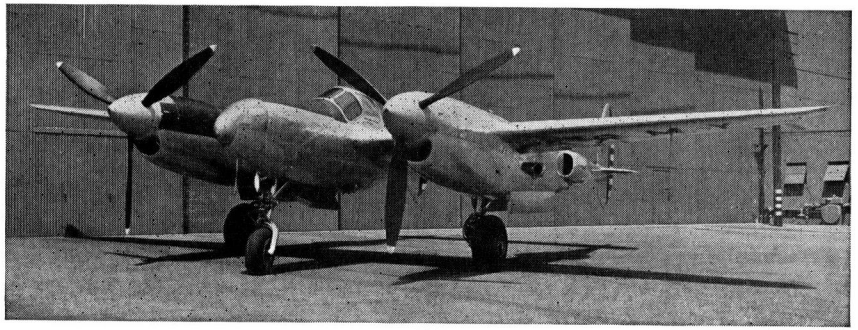
LOCKHEED XP-49 U.S.A.

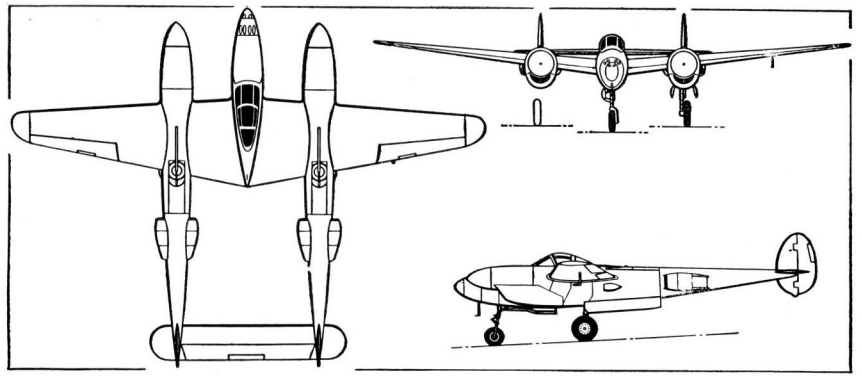
Within a few months of the successful first flight of the XP-38 Lightning, Lockheed's design team was working on a more advanced development of the basic design in answer to the Army Air Corps' Circular Proposal 39-775. Originally designated Model 222 by the manufacturer but later redesignated Model 522 when the earlier model number was assigned to the production P-38, the new fighter differed from the early Lightning principally in having Pratt and Whitney X-1800 twenty-four cylinder engines, and was one of four projects submitted by various aircraft manufacturers. The Lockheed proposal was awarded first place in the subsequent evaluation, receiving the designation XP-49, and Grumman's G-46 took second place, receiving the designation XP-50.

The Lockheed XP-49 was ordered in October 1939, the contract for one prototype being approved on January 8, 1940. Substantially similar to the YP-38, the XP-49 as originally envisaged was powered by two X-1800-2G engines with which a maximum speed of 473 m.p.h. at 20,000 ft. was expected and featured a pressurized cabin and an armament of two 20-mm. cannon and four 0.5-in. machine guns, but two months after the contract had been approved, it was decided to switch to Continental XI-1430-1 twelve-cylinder liquid-cooled inverted-vee engines. Other changes at this time included the substitution of dummy armour plate for the genuine armour called for by the original specification, this expediting the construction of the prototype. A maximum speed of 458 m.p.h. at 25,000 ft. was now anticipated.

On November 11, 1942, the XP-49 was flown for the first time, and three additional flight tests were undertaken before, on November 20th, the prototype was temporarily removed from flight status for the replacement of the original engines and the installation of P-38-type fuel tanks. The test programme was resumed on January 1, 1943, but a crash landing resulted when a hydraulic system and an electric system failed simultaneously, the port undercarriage leg failed to lock in the down position, and the flaps operated incorrectly.

The sole prototype XP-49 in its original single-seat form.





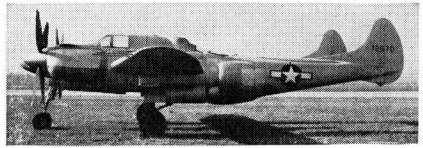
Repairs were effected and the XP-49 flew again on February 16, 1943, but preliminary performance data indicated that maximum speed was not sufficiently higher than that of the production P-38 Lightning to warrant switching the assembly lines to the newer fighter, and this fact, added to the questionable production future of the Continental engine, led to the abandoning of any further consideration of quantity production. The XP-49 was therefore transferred to Wright Field for participation in the development programme of the Continental engine. A two-seat cockpit was fitted so that a test observer could be carried, and the aircraft was ferried to Wright Field on June 25, 1943. Leakage of the self-sealing fuel tanks necessitated modifications, and the aircraft did not fly again until May 1944. During an early flight after testing was resumed, the port engine failed, and although the prototype was undamaged, further work on the XP-49 was abandoned.

Type: *Single-seat Interceptor Fighter.* **Power Plants:** *Two* 1,600 *h.p. Continental XI*-1430-1 *twelve-cylinder inverted-Vee liquid-cooled engines.* **Armament:** (*Proposed*) *Two* 20-*mm. cannon with* 60 *r.p.g. and four* 0.5-*in. machine guns with* 300 *r.p.g.* **Performance:** *Maximum speed,* 406 *m.p.h. at* 15,000 *ft.,* 384 *m.p.h. at* 10,000 *ft.,* 347 *m.p.h. at sea level; initial climb rate,* 3,300 *ft./min.; time to* 20,000 *ft.,* 8.7 *min.; range,* 679 *mls.* **Weights:** *Empty,* 15,410 *lb.; loaded,* 18,750 *lb.* **Dimensions:** *Span,* 52 *ft.* 0 *in.; length,* 40 *ft.* 1 *in.; height,* 9 *ft.* 9½ *in.; wing area,* 327.5 *sq. ft.*

LOCKHEED XP-58 U.S.A.

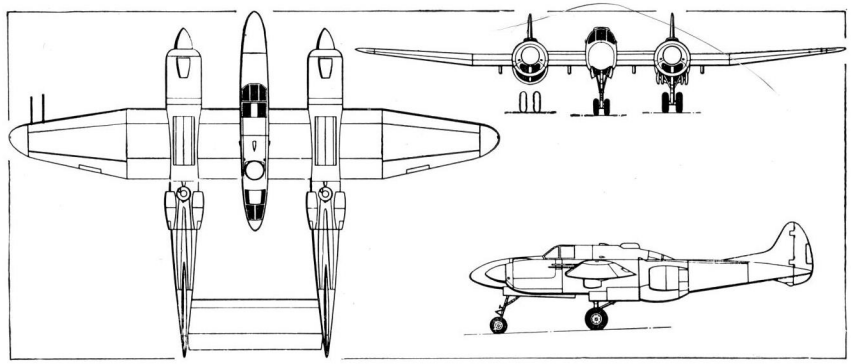
Under an agreement between the Army Air Corps and Lockheed of April 12, 1940 whereby the Lightning was released for sale to Britain, Lockheed undertook to develop and deliver to the A.A.C. an improved version of the Lightning without cost to the U.S. government. A requirement for a long-range fighter suitable for accompanying bomber formations was formulated, and the improved version of the Lightning visualised for this role. To be powered by two Continental IV-1440 engines and equipped with one 20-mm. cannon and four 0.5-in. guns as a single-seater, and a flexible 0.5-in. gun in the end of each tailboom as a two-seater, the aircraft was expected to attain 450 m.p.h. at 25,000 ft.

By July 1940, when thought was first given to the use of Pratt and Whitney XH-2600 engines instead of the Continentals, it had been decided that the aircraft would be a two-seater and the project had been designated XP-58. Three months later, Lockheed were informed that development of the XH-2600 engine was being discontinued, and the design team began investigating the possibility of installing Pratt and Whitney R-2800 engines with turbo-superchargers. The A.A.F. was not satisfied that the maximum speed of 418 m.p.h. at 25,000 ft. now quoted would be adequate two years later when the aircraft was scheduled to begin its flight test programme. It was decided, therefore, to make further modifications in the specification to incorporate two Wright R-2160 Tornado engines each rated at 2,350 h.p. With these power plants, estimated maximum speed rose to 450 m.p.h. It was about this time that it was decided to equip the XP-58 with two rear turrets, one upper and one lower, each containing two 0.5-in. guns.



The XP-58 was never fitted with armament or cabin pressurization equipment.

The demand for additional equipment, including a pressure cabin for the two crew members, resulted in continual increases in estimated gross weight which, by August 1941, had grown to 34,242 lb. In March 1942 Lockheed proposed the construction of a second XP-58, and the A.A.F. agreed to this proposal, but as there was now some doubt concerning the availability of the Tornado engines before the spring of 1943, it was felt that time was available to permit the redesign of certain features of the second machine in order to obtain a range of 3,000 miles. Thought was also given to the installation of a 75-mm. cannon with automatic feed for twenty shells. By September 1942, when some ninety per cent of the first XP-58's components had been manufactured, the decision was taken to convert the aircraft for the role of low-altitude tank-destroyer. This introduced many complications and, in the following month, the



second XP-58 was cancelled. As the XA-38 Grizzly was being developed to undertake an identical role to that now foreseen for the XP-58, the earlier decision was abandoned and the XP-58 once again became a high-altitude aircraft but was now intended to break up bomber formations by bombarding them with 75-mm. shells.

In February 1943, owing to lack of progress with the Tornado development programme, consideration was given to the installation of turbo-supercharged Allison V-3420 engines, and shortly afterwards work was resumed on the second prototype. The first XP-58 finally flew for the first time on June 6, 1944, but the flight test programme was considerably curtailed owing to work of higher priority on other projects. Considerable trouble was experienced with torching from the turbo-superchargers, and after twenty-five flights the XP-58 was ferried to Wright Field for A.A.F. acceptance tests. At this time the XP-58 had no cabin pressurization equipment, the turrets and related fire-control equipment were omitted, and the nose armament had not been installed. The XP-58 reached Wright Field on October 22, 1944, but the maintenance of the prototype proved such a liability that no further trials were undertaken and construction of the second XP-58 was abandoned.

Type: *Two-seat High-altitude Bomber-destroyer.* **Power Plants:** *Two* 3,000 *h.p. Allison V-3420-11/13 twenty-four-cylinder liquid-cooled engines.* **Armament:** (*Proposed*) *Four* 37-*mm. cannon with* 250 *r.p.g. and four* 0.5-*in. machine guns in two remotely-controlled flexible turrets, or one* 75-*mm. cannon with* 20 *rounds and two* 0.5-*in. guns with* 300 *r.p.g. in nose plus two turrets.* **Performance:** *Maximum speed,* 436 *m.p.h. at* 25,000 *ft.; cruising speed,* 274 *m.p.h. at* 25,000 *ft.; initial climb rate,* 2,660 *ft./min.; service ceiling,* 38,400 *ft.* **Weights:** *Empty,* 31,624 *lb.; maximum loaded,* 39,192 *lb.* **Dimensions:** *Span,* 70 *ft.* 0 *in.; length,* 49 *ft.* 4 *in.; height,* 16 *ft.* 0 *in.; wing area,* 600 *sq. ft.*

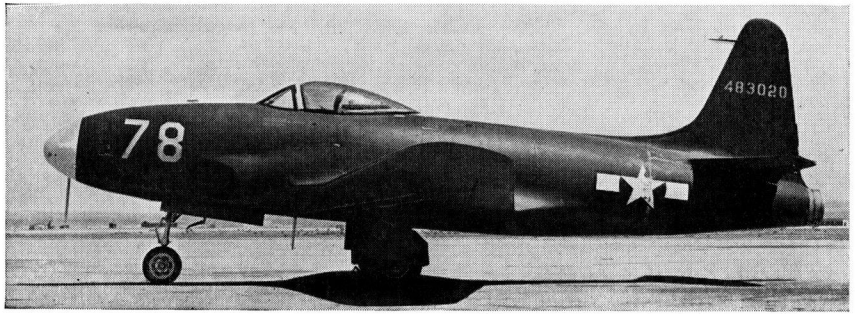
LOCKHEED P-80A SHOOTING STAR — U.S.A.

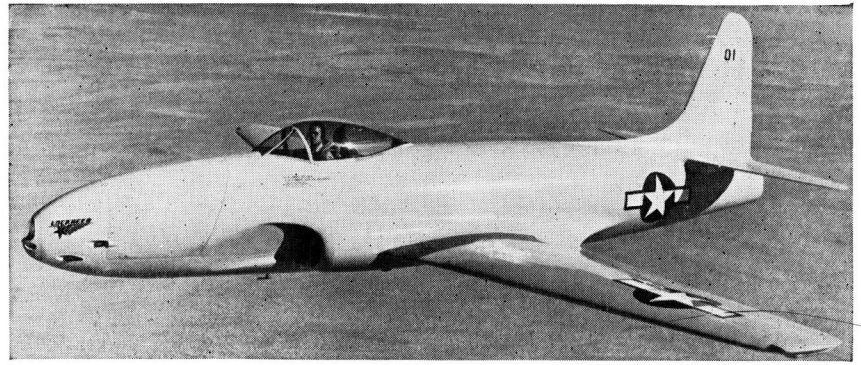
The Shooting Star was the first turbojet-driven combat aircraft to be accepted by the U.S.A.A.F. for operational service, but was too late to see action during the Second World War. The Shooting Star stemmed indirectly from preliminary design studies for a single-seat, single-jet fighter powered by a Whittle W2B or General Electric I-16 fed via wing-root intakes undertaken by Bell Aircraft as the XP-59B in 1942. Owing to Bell's extensive commitments in other directions, however, the project was turned over to Lockheed Aircraft who, retaining the same basic configuration, evolved an extremely clean design around an imported de Havilland H-1B (Goblin) turbojet of 2,460 lb. thrust. Redesignated XP-80, the prototype was begun on June 23, 1943, and in 143 days the aircraft was completed, flying for the first time on January 9, 1944. The XP-80 weighed 6,287 lb. empty and 8,916 lb. loaded, and during trials it attained a maximum speed of 502 m.p.h. at 20,480 ft., a service ceiling of 41,000 ft., and an initial climb rate of 3,000 ft./min.

Initial plans to power production aircraft with an Allis-Chalmers version of the H-1B turbojet did not see fruition owing to production delays with this engine, and the design was therefore extensively modified for the 3,850 lb.s.t. General Electric I-40 (J33) engine, two further prototypes being ordered with the larger turbojet as XP-80As. Overall length was increased twenty inches, wing span was increased by two feet, the air intakes and ducting were redesigned, and a twenty-five per cent increase in loaded weight necessitated a new undercarriage. The first XP-80A was flown on June 11, 1944, followed closely, on September 13th, by the first of thirteen YP-80A Shooting Stars for service evaluation, these being essentially similar to the XP-80A.

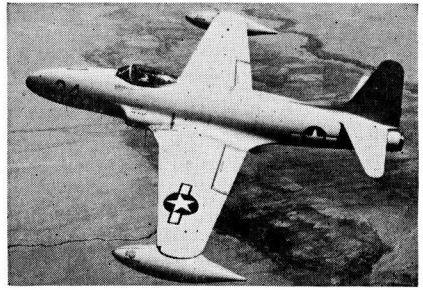
Orders were placed for no less than five thousand P-80As, of which one thousand were to be built at North America's Dallas factory,

The original XP-80 with an imported de Havilland H-1B turbojet.





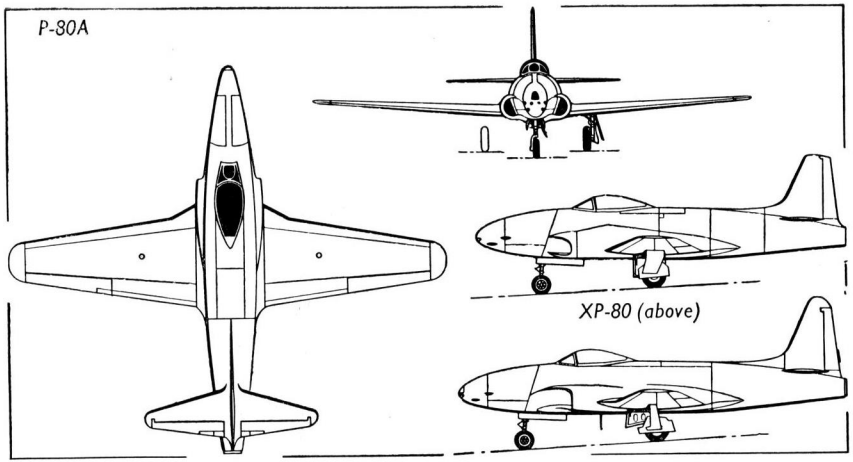
(*Above*) *The first XP-80A and* (*right*) *the twelfth YP-80A.*



and the first aircraft appeared in February 1945. The first production batch of P-80A Shooting Stars received the General Electric J33-GE-9, but subsequent batches received the improved J33-GE-11 and the Allison-built J33-A-17. V-J Day resulted in a cut-back in production contracts to 917 aircraft, post-war developments including the P-80B and P-80C.

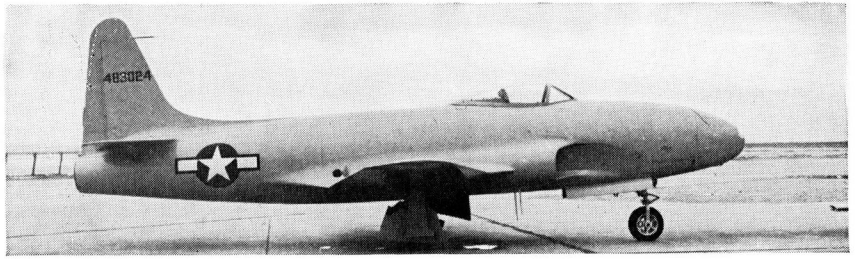
The following specification relates to the P-80A-1-LO Shooting Star.

Type: *Single-seat Interceptor Fighter and Fighter-bomber.* **Power Plant:** *One* 3,850 *lb.s.t. General Electric J33-GE-9 or* -11 *centrifugal-type turbojet.* **Armament:** *Six* 0.5-*in. Colt-Browning M2 machine guns with* 300 *r.p.g. plus two* 500-*lb. or* 1,000-*lb. bombs or* (100*th and subsequent aircraft*) *ten* 5-*in. rockets.* **Performance:** *Maximum speed,* 558 *m.p.h. at sea level,* 548 *m.p.h. at* 10,000 *ft.,* 533 *m.p.h. at* 20,000 *ft.,* 492 *m.p.h. at* 40,000 *ft.; range* (*clean*), 625 *mls. at* 416 *m.p.h. at* 25,000 *ft.,* 780 *mls. at* 410 *m.p.h. at* 35,000 *ft.,* (*with two* 137 *Imp. gal. drop tanks*), 1,100 *mls.* at 407 *m.p.h. at* 25,000 *ft.,* 1,320 *mls. at* 388 *m.p.h. at* 35,000 *ft.; time to* 5,000 *ft.,* 1.2 *min., to* 10,000 *ft.,* 2.4 *min., to* 20,000 *ft.,* 5.5 *min.; service ceiling,* 45,000 *ft.*



Weights: *Empty,* 7,920 *lb.; normal loaded,* 11,700 *lb.; maximum,* 14,000 *lb.* **Dimensions:** *Span,* 38 *ft.* 10½ *in.; length,* 34 *ft.* 6 *in.; height,* 11 *ft.* 4 *in.; wing area,* 238 *sq. ft.*

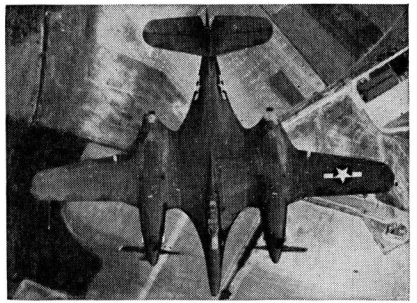
The second YP-80A Shooting Star which later became the XF-14.

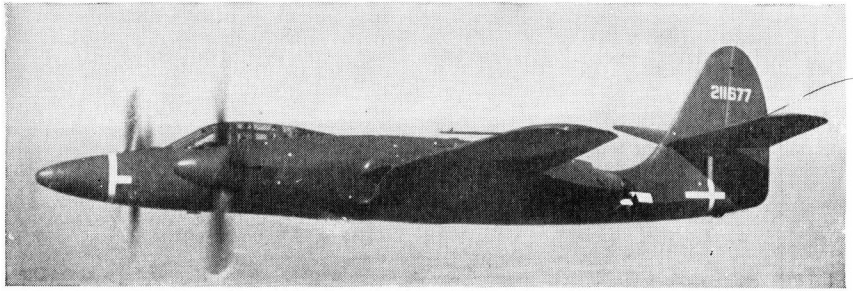


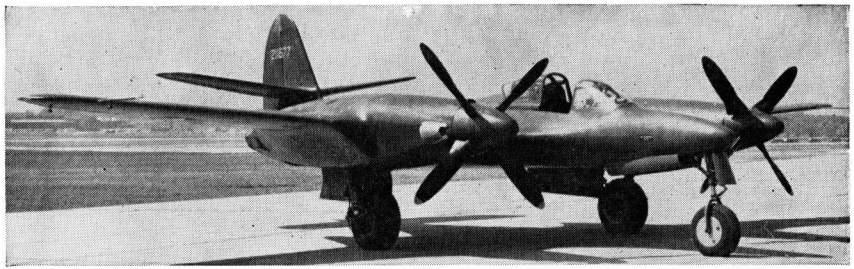
MCDONNELL XP-67 U.S.A.

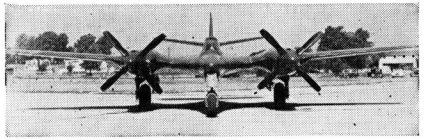
Formed on July 6, 1939, the McDonnell Aircraft Corporation immediately began design studies for a long-range fighter, submitting proposals to the Army Air Corps for an unconventional machine with an Allison V-3420-B2 or Pratt and Whitney H-3130 engine with a two-stage supercharger buried in the fuselage aft of the pilot, and driving two pusher airscrews aft of the wings by means of extension shafts and right-angle gear drives. Although the fledgeling company's proposals were not accepted by the A.A.C. owing to excessive weight and the development period required for the engine and gear drives, the novel features of the design were of sufficient interest to warrant the purchase of further engineering information.

Thus encouraged, McDonnell completely redesigned their projected fighter, firstly as a two-seater and finally as a single-seater, and on July 29, 1941, the project received the designation XP-67, and two prototypes were ordered. McDonnell's design team attempted to maintain true aerofoil sections throughout the entire fighter, the centre fuselage and the rear portions of the engine nacelles merging to give the aircraft a unique appearance. Power was provided by two Continental XI-1430-1 engines fitted with General Electric D-2 turbo-superchargers driving four-blade air-









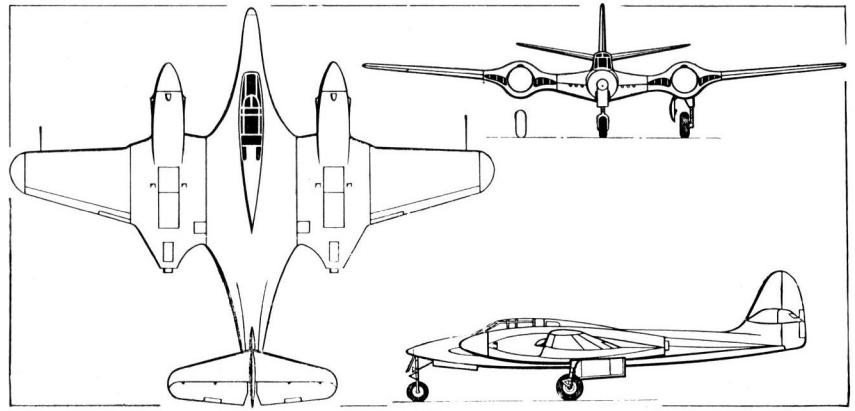
screws and using the exhaust to augment thrust. A single-seat, pressurised cabin was provided, and armament comprised six 0.5-in. machine guns and four 20-mm. cannon, and guaranteed maximum speed and estimated gross weight were 472 m.p.h. and 18,600 lb. respectively. The proposed armament was subsequently changed to six 37-mm. cannon, and it was suggested that a comparison should be made between this phenomenally heavy armament and a single 75-mm. cannon. The armament change and other revisions raised the estimated gross weight to 20,000 lb.

By December 1, 1943, the first XP-67 was complete apart from armament, cabin pressurisation equipment, the oxygen system and provision for drooping ailerons, and ground trials began immediately. By this time, the engines were XI-1430-17/19s with D-23 turbo-superchargers, but on December 8th fires started in both engine nacelles during a run-up owing to the malfunctioning of the exhaust manifold slip rings, this mishap delaying the commencement of flight trials. The XP-67 eventually flew for the first time on January 6, 1944, but this test lasted only six minutes and terminated in an emergency landing owing to difficulties with the experimental engines. After the installation of a stainless-steel bulkhead sealing off the turbo compartment from the rest of the engine nacelle, improvements to the cooling air circulatory system, and some shortening of the aft ends of the engine cowlings, second and third flights were accomplished successfully. During the fourth flight, on February 1, 1944, the Continental engines were unintentionally overspeeded, however, and the bearings burned out.

Since replacement engines were not immediately available, the XP-67 was returned to McDonnell's plant where the tailplane was raised one foot, a change dictated by wind tunnel tests. Flight trials were resumed on March 23, 1944, and between the 11th and 13th of May five test flights were made by U.S.A.A.F. pilots who reported that the cockpit layout was fair, and taxi-ing and ground handling were generally satisfactory, but that the take-off was long, the initial climb rate poor, acceleration low, and that the aircraft gave the impression of being underpowered. All controls were effective at all speeds, although the ailerons were a little heavy at high speeds. Stick forces were light, the trim controls were very effective, the roll rate good at high speed, and the fighter was stable longitudinally but neutrally stable laterally and tended to "Dutch roll".

Flight trials continued throughout the summer of 1944, and a dorsal fin and an additional two degrees of dihedral on the tailplane were adopted to increase lateral stability. Official performance tests were to be undertaken in September 1944, but on the 6th of that month the XP-67 was irreparably damaged by fire. This accident, the unsatisfactory nature of certain aspects of the fighter's performance, and the inordinate amount of time required to complete the second prototype combined to result in the termination of the development contract.

Type: *Single-seat Long-range Fighter.* **Power Plants:** *Two* 1,350 *h.p. Continental XI*-1430-17/19 *twelve-cylinder inverted-Vee liquid-cooled engines.* **Armament:** (*Proposed*) *Six* 37-*mm. M*-4 *cannon with* 45 *r.p.g.* **Performance:** *Maximum speed,* 405 *m.p.h. at* 25,000 *ft.,* 357 *m.p.h. at* 10,000 *ft.; maximum climb rate,* 2,600 *ft./min.; service ceiling,* 37,400 *ft.; maximum range,* 2,385 *mls.* **Weights:** *Empty,* 17,745 *lb.; normal loaded,* 22,114 *lb.; maximum,* 25,400 *lb.* **Dimensions:** *Span,* 55 *ft.* 0 *in.; length,* 44 *ft.* 9¼ *in.; height,* 15 *ft.* 9 *in.; wing area,* 414 *sq. ft.*

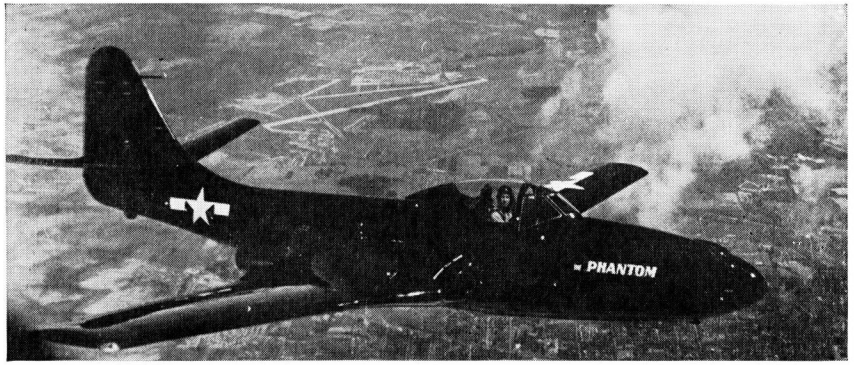


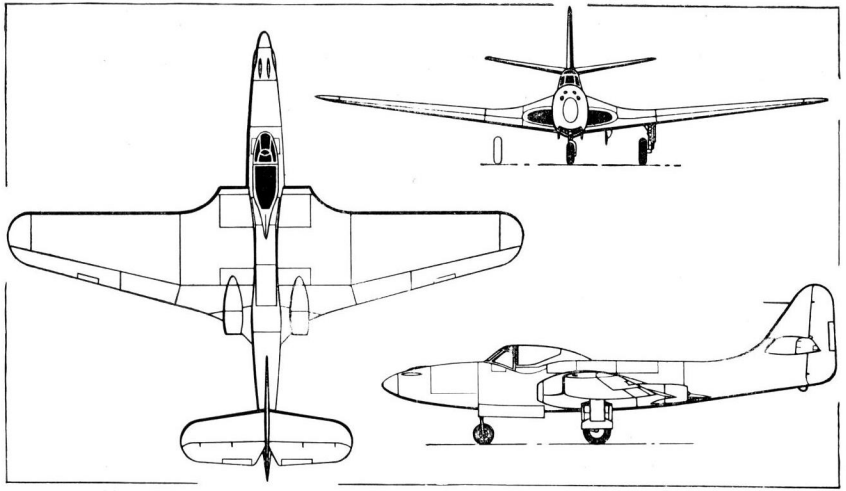
MCDONNELL XFD-1 PHANTOM — U.S.A.

The first U.S. pure jet aircraft designed from the outset for shipboard operations, the McDonnell Phantom was conceived at a time when it was generally believed that, since turbojet engines were apparently a great deal simpler than piston engines, they could be scaled up or down to suit a particular airframe, reversing the practice of tailoring an airframe for a specific engine.

In the event, it was to be discovered that the development of compressors and combustion chambers of various sizes was by no means as simple as had at first been assumed. However, when McDonnell were invited to co-operate in the development of a shipboard jet fighter at the beginning of 1943, the Westinghouse Electric Corporation were designing a series of turbojets ranging in diameter from 9.5 to 19 inches, and after discarding various unorthodox airframe configurations, a conservative layout was adopted with no less than six 275–340 lb. thrust 9.5-in. diameter turbojets in the wings. A fundamental consideration was that the fighter should be as small as possible, but it was soon discovered that with the six turbojets thrust loading and wing loading would both be unacceptably high for carrier operation. The gross wing area of the fighter was accordingly increased from 187 to 230 sq. ft., and comparisons were made between eight 9.5-in. diam., six 11-in. diam., four 13.5-in. diam., and two 19-in. diam. engines. It was ascertained that nearly 300 lb. could be saved with the last-mentioned arrangement which also simplified structural design, control and instrumentation. Thus, late in 1943, several months after August 30th when three prototypes had been ordered under the designation XFD-1, the fighter's basic configuration was finalised.

In order to keep air intake and exhaust ducts to minimum length, the turbojets were buried





in the wing roots, this arrangement offering greater aerodynamic efficiency than simpler underwing nacelles, and provision was made for the mounting of four 0.5-in. guns in the nose. The first XFD-1 was completed at the beginning of January 1945, but only one Westinghouse 19XB-2B engine was available for installation. Such was the confidence in the fighter, however, that, on January 26, 1945, after ground runs and taxi-ing trials, the first flight test was made with only one turbojet installed. This test was completely successful and, on March 7, 1945, a production contract was placed for one hundred FD-1s (later redesignated FH-1s). This contract was reduced to sixty aircraft with the end of the war, the first being delivered in January 1947, six months after an XFD-1 had become the first pure jet aircraft to operate from a U.S. carrier.

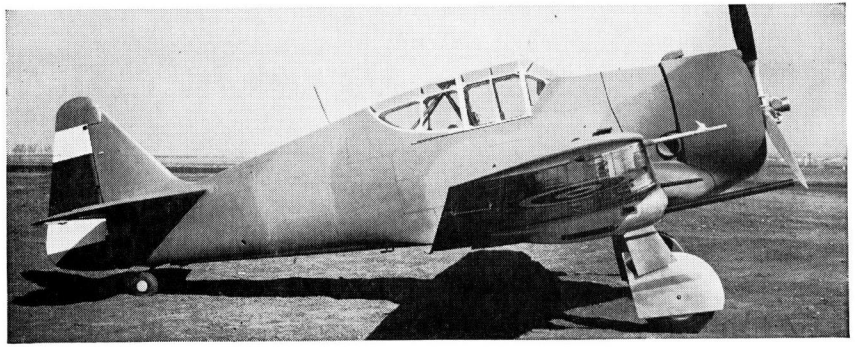
Type: *Single-seat Shipboard Interceptor.* **Power Plants:** *Two* 1,600 *lb.s.t. Westinghouse WE-19XB-2B axial-flow turbojets.* **Armament:** *Four* 0.5-*in. Browning machine guns.* **Performance:** *Maximum speed,* 487 *m.p.h. at sea level,* 483 *m.p.h. at* 20,000 *ft.; initial climb rate,* 4,960 *ft./min.; service ceiling,* 43,700 *ft.; normal range,* 540 *mls. at* 250 *m.p.h.; maximum range,* 750 *mls.* **Weights:** *Empty,* 6,156 *lb.; normal loaded,* 8,626 *lb.; maximum,* 9,531 *lb.* **Dimensions:** *Span,* 40 *ft.* 9 *in.; length,* 37 *ft.* 3 *in.; height,* 14 *ft.* 1½ *in.; wing area,* 276 *sq. ft.*

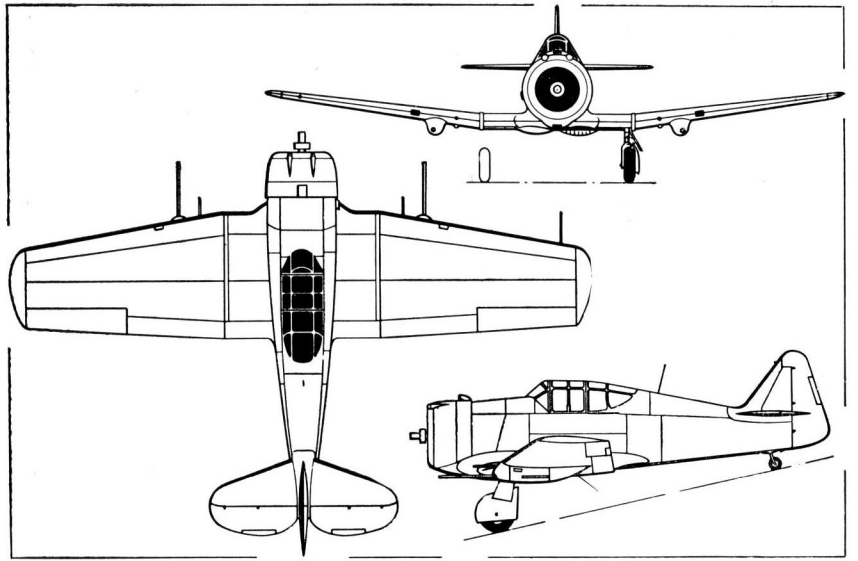
NORTH AMERICAN P-64 U.S.A.

From the North American NA-16 experimental basic training monoplane of 1935 a whole family of military aircraft was evolved, among which were some of the most successful advanced and basic training machines ever produced by any country. Less well-known, however, were the single-seat fighters developed from the basic design for export to smaller nations requiring relatively simple warplanes yet machines embodying such modern features as enclosed cockpits and retractable undercarriages.

The first of these single-seat variants was the NA-50A which, based on the two-seat NA-26, the first development of the NA-16 to incorporate a retractable undercarriage, was built for the Peruvian Air Force. The NA-50A was powered by an 870 h.p. Wright R-1820-77 air-cooled radial engine and carried an armament of two 0.3-in. Colt-Browning machine guns. It attained a maximum speed of 295 m.p.h. at 9,500 ft., a range of 645 mls., and a service ceiling of 32,000 ft. Seven fighters of this type were purchased by Peru, deliveries being completed in May 1939, and in Peruvian service these aircraft were fitted with bomb racks beneath the fuselage for light bombs. During the fighting between Peruvian and Ecuadorian forces in 1941, the NA-50As undertook a number of operational sorties, two being lost in action, one being hit by anti-aircraft fire and the other exploding in the air while the pilot was endeavouring to dislodge a bomb hanging from its rack.

Following France's defeat, six examples of a fighter basically similar to the NA-50A were ordered for the Royal Thai Air Force. Designated NA-68, these aircraft differed from those supplied to Peru principally in having heavier armament, redesigned tail surfaces similar to those adopted for later production models of the advanced trainer, and





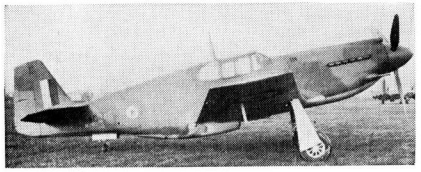
modified undercarriage. The six NA-68s were aboard ship at Hawaii en route to Thailand when the Japanese invaded that country. The fighters were therefore seized by the U.S. government, returned to the U.S.A., and, with cannon armament removed, were assigned to advanced fighter training schools as the P-64. It is of interest to compare the NA-68 with the Commonwealth CA-12 Boomerang (Volume I, page 4) which, developed in Australia, was also a single-seat fighter evolved from the basic NA-16 trainer design.

Type: *Single-seat Fighter-bomber.* **Power Plant:** *One* 870 *h.p. Wright R*-1820-77 *Cyclone nine-cylinder radial air-cooled engine.* **Armament:** *Two* 0.3-*in. machine guns and two* 20-*mm. cannon plus four* 100-*lb. bombs.* **Performance:** *Maximum speed,* 270 *m.p.h. at* 8,700 *ft.; normal range,* 635 *mls. at* 235 *m.p.h.; maximum range,* 965 *mls.; service ceiling,* 27,500 *ft.* **Weights:** *Empty,* 4,660 *lb.; normal loaded,* 5,990 *lb.; maximum,* 6,800 *lb.* **Dimensions:** *Span,* 37 *ft.* 3 *in.; length,* 27 *ft.* 0 *in.; height,* 19 *ft.* 8 *in.; wing area,* 227.5 *sq. ft.*

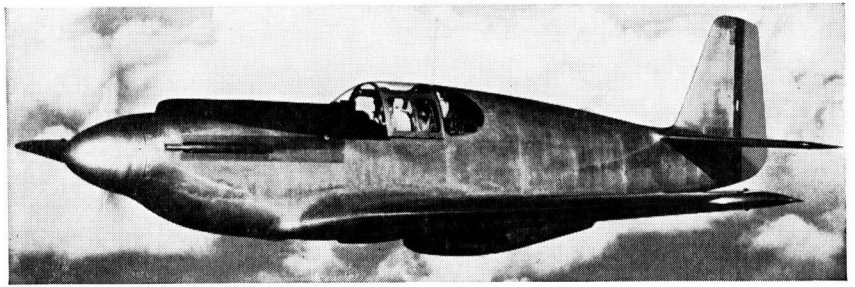
NORTH AMERICAN P-51–P-51A MUSTANG U.S.A.

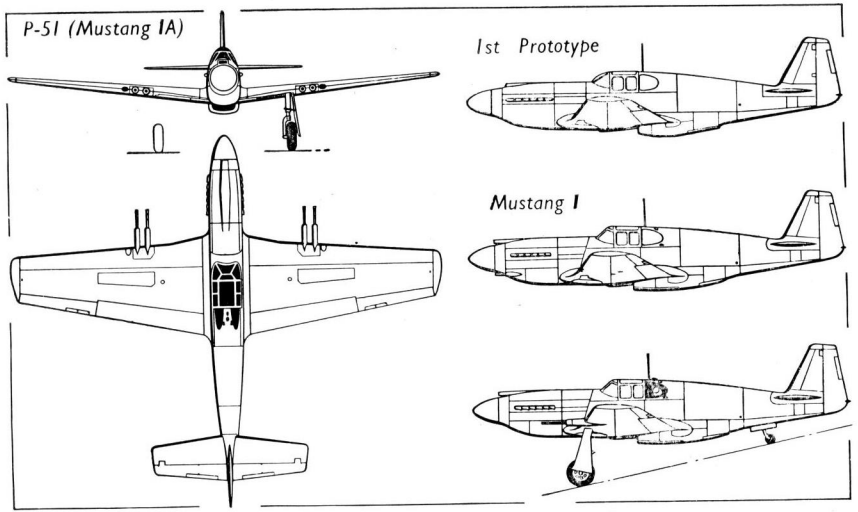
Perhaps the most successful piston-engined single-seat fighter produced by any nation during World War II, the Mustang owed its origin to the British Air Purchasing Commission which, in April 1940, asked North American Aviation to manufacture the Curtiss Hawk 87A-1 for the R.A.F. This proposal was countered by a suggestion from North American's president, J. H. Kindelberger, that his company produce an entirely new fighter which, designed around the same Allison V-1710-39 engine, would be superior on all counts to the Curtiss fighter. The broad outlines of the proposed fighter had already been conceived as a result of air combat reports from Europe, and the Commission agreed to the proposal on the understanding that the aircraft met the requirements that they had formulated. It was also stipulated that, in view of the serious war situation, a prototype must be completed within 120 days.

The NA-73X, as the prototype was designated by its manufacturers, was designed by a team headed by Raymond Rice and Edgar Schmued, and was pushed out of the assembly shed in 117 days—although lacking an engine and having wheels borrowed from an AT-6 basic trainer. A delay in the delivery of the V-1710-39 prevented the first test flight from being made until October 26, 1940, by which time the first British contract for 320 NA-73 fighters had been placed, this being approved by the U.S. government with the proviso that two machines from the initial production batch be transferred to the Army Air Corps for evaluation. These two aircraft,



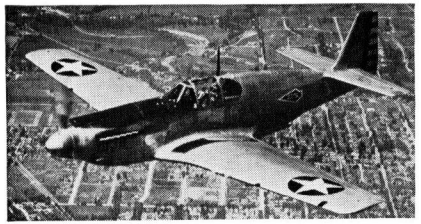
(Below) The NA-73X prototype Mustang and (left) the second production NA-73 Mustang I (AG346).





which, in the event, were the fifth and tenth production NA-73s, were designated XP-51 in a contract dated September 20, 1940.

One of the first fighters to employ a laminar flow wing, the NA-73X encountered very few difficulties during its test programme, production starting almost immediately. Weighing 6,278 lb. empty and 7,965 lb. in normal loaded condition, the first production aircraft flew for the first time on May 1, 1941, this aircraft being retained by North American for flight development purposes, and the second production machine arrived in the United Kingdom in the following November, being dubbed Mustang I. The new fighter was immediately recognised as being infinitely superior to any previous American fighter, although handicapped by the low-rated altitude of its Allison engine which prevented its use for normal fighter duties. However, its extremely high speed and excellent manoeuvrability at low altitudes rendered it ideal for tactical reconnaissance, while its armament of four 0.5-in. and four 0.3-in. guns provided the Mustang with good ground attack potential. An F.24 camera was mounted obliquely aft of the pilot's seat, and the Mustang I entered service with Army Co-operation Command, supplanting the Tomahawk. It first entered service in April 1942 with No. 2 Squadron at



The second XP-51 Mustang.

Sawbridgeworth, and its first operational sortie took place on July 27th. Subsequently, Mustangs photographed Dieppe before the costly British Commando attack on that port, subsequently supporting the assault troops. In October 1942 the Mustang I gained the distinction of becoming the first single-engined fighter based in the United Kingdom to penetrate beyond the German border, this event taking place during a raid on the Dortmund-Ems Canal.

In the meantime, Britain had placed contracts for a further 300 Mustang Is which, embodying minor modifications, were designated NA-83 by the manufacturer, and Lend-Lease funds had been used in September 1940 to order 150 NA-91s which differed from early models in having a wing-mounted armament of four 20-mm. cannon. These received the A.A.F. designation P-51 and were briefly assigned the name Apache, although this was quickly dropped in favour of the British appellation to avoid confusion. Ninety-three NA-91s were delivered to the United Kingdom for service with the R.A.F., these being known as Mustang IAs, and fifty-five were each fitted with two K-24 cameras, entering service with the A.A.F. as F-6A tactical reconnaissance aircraft. The last two NA-91s were converted under the company designation NA-101 to take the Packard-built Merlin V-1650-3, and after a brief period as XP-78s, these were redesignated XP-51Bs.

After conducting extremely successful trials with the two XP-51s, the A.A.F., whose fighter policy at that time hinged mainly on the P-38 Lightning and the P-47 Thunderbolt, began to evince more interest in the North American fighter, placing an order for 500 examples of the NA-97, a version of the Mustang evolved in the spring of 1942 specifically for dive-bombing. Designated A-36A by the A.A.F., delivery of this type began in September 1942 and was completed during the following March. Fitted with wing-mounted air brakes (which were eventually wired shut when this type joined combat), underwing racks for two 500-lb. bombs, and a built-in armament of six 0.5-in. guns, the A-36A was powered by an Allison V-1710-87 engine rated at 1,325 h.p. at 3,000 ft. Normal and maximum loaded weights rose to 8,370 lb. and 10,700 lb., and maximum speed in clean condition fell to 356 m.p.h. at 5,000 ft., and 310 m.p.h. with the two 500-lb. bombs fitted. With bombs, range and service ceiling were 550 miles and 25,100 ft. respectively, and the A-36A was the first A.A.F. version of the Mustang to see combat, equipping two groups in Sicily and Italy in 1943, although the type was only moderately successful. One A-36A was supplied to the R.A.F. in March 1943 for experimental purposes.

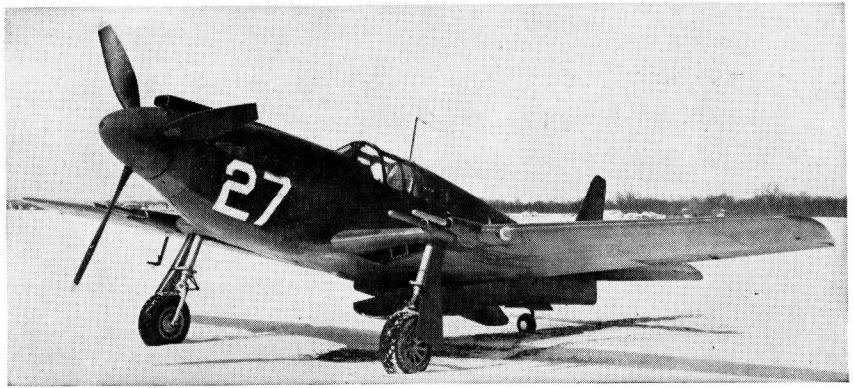
The A-36As were followed by 310 NA-99s or P-51As, deliveries beginning in March 1943. Powered by the 1,200 h.p. V-1710-81 engine, the P-51A carried an armament of four 0.5-in. wing-mounted guns and underwing racks for two 250-lb., 325-lb., or 500-lb. bombs, or two 62.5 or 125 Imp. gal. drop tanks. Maximum take-off weight rose to 10,600 lb., but maximum ferrying range was increased to 2,350 mls. Fifty P-51As were supplied to the R.A.F. as Mustang IIs to replace the NA-91s retained by the A.A.F. for conversion as F-6As, and thirty-five were fitted with two K-24 cameras as F-6Bs.

With the P-51A-10-NA production batch, manufacture of the Allison-engined Mustang terminated in favour of the Merlin-powered model. A total of 1,579 Allison-Mustangs had been built, and as the Mustang I, IA and II, there were operated by R.A.F. squadrons Nos. 2, 4, 13, 16, 26, 63, 116, 168, 225, 239, 241, 268, 309, 315, 400, 414, 430, 485 and 613. In A.A.F. service, apart from the A-36s in the Mediterranean theatre, two squadrons of F-6A tactical reconnaissance aircraft were operated during the Tunisian campaign.

The following specification relates to the P-51A-10-NA, the performances of other Allison-powered models being generally similar.

Type: *Single-seat Medium-altitude Fighter-bomber.* **Power Plant:** *One* 1,200 *h.p. Allison V-*1710-81 *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Four* 0.5-*in. Browning MG* 53-2 *machine guns with* 350 (*inboard pair*) *and* 280 (*outboard pair*) *r.p.g., plus two* 250, 325, *or* 500-*lb. bombs.* **Performance:** *Maximum speed,* 340 *m.p.h. at* 5,000 *ft.,* 360 *m.p.h. at* 10,000 *ft.,* 380 *m.p.h. at* 15,000 *ft.,* 390 *m.p.h. at* 20,000 *ft.; range* (150 *Imp. gal. internal fuel*), 750 *mls. at* 300 *m.p.h. at* 10,000 *ft.,* 1,000 *mls. at* 232 *m.p.h. at* 10,000 *ft.,* (*with two* 125 *Imp. gal. drop tanks*), 2,000 *mls. at* 266 *m.p.h.,* 2,350 *mls. at* 228 *m.p.h.; time to* 5,000 *ft.,* 2.2 *min., to* 10,000 *ft.,* 4.4 *min., to* 20,000 *ft.,* 9.1 *min.; service ceiling,* 31,350 *ft.* **Weights:** *Empty,* 6,433 *lb.; normal loaded,* 8,600 *lb.; maximum,* 10,600 *lb.* **Dimensions:** *Span,* 37 *ft.* 0¼ *in.; length,* 32 *ft.* 2½ *in.; height,* 8 *ft.* 8 *in.; wing area,* 233 *sq. ft.*

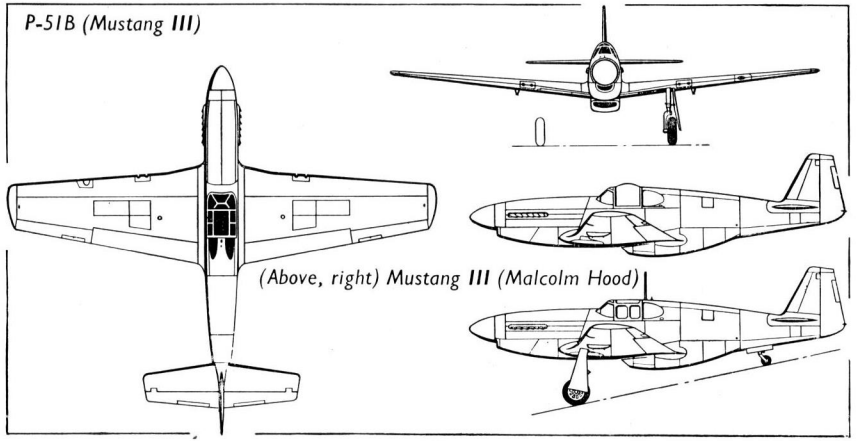
The cannon-armed NA-91, or P-51, ninety-three of which were supplied to the R.A.F. as Mustang IAs.

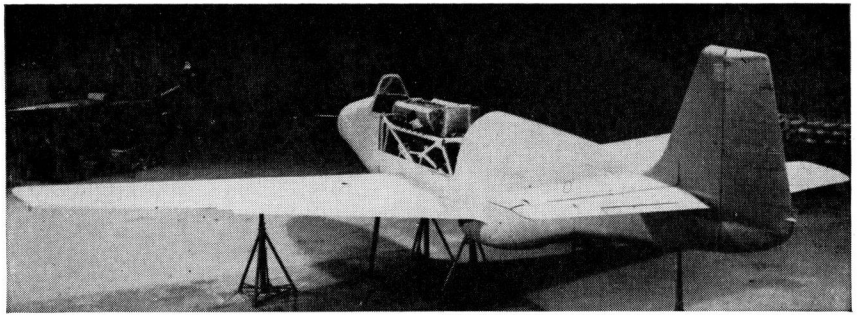


NORTH AMERICAN P-51B–P-51C MUSTANG U.S.A.

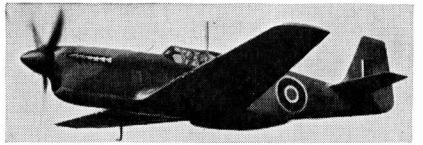
The Mustang had been handicapped from the outset by the low-rated altitude of its Allison engine, and shortly after the arrival of the first Mustang Is in the United Kingdom, consideration was given to the cross-breeding of the airframe with the Rolls-Royce Merlin 61 engine to improve the fighter's high-altitude capabilities, a development which was destined to bring the North American design to fruition as the pre-eminent all-round fighter of World War II.

Four Mustang Is were delivered to Rolls-Royce at Hucknall. Known as Mustang Xs, these aircraft were fitted with the Merlin 61 or 65 and four-bladed airscrews to absorb the extra power, and featured small chin-type radiators of varying shape while retaining the ventral radiators originally fitted. The Merlin installations were completed and the Mustang Xs successfully flown within six weeks of the programme being initiated. Details were immediately transmitted to the North American company who had already begun the adaptation of two P-51 (NA-91) airframes to take the U.S.-built Packard Merlin V-1650-3 engine as XP-51Bs (NA-101s). The airframes were strengthened in order to take full advantage of the increased power available; the ventral radiator was deepened; the carburettor intake was moved from above to below the nose for the Merlin's up-draught induction system, and new ailerons were fitted. The original quartette of 20-mm. cannon was retained. Flight tests with the XP-51B began

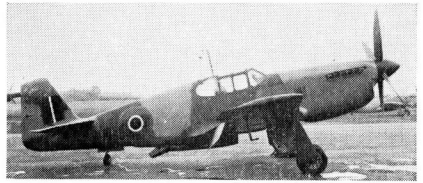




(Above) The mock-up of Rolls-Royce's proposal to mount a Merlin engine in the Mustang aft of the cockpit.

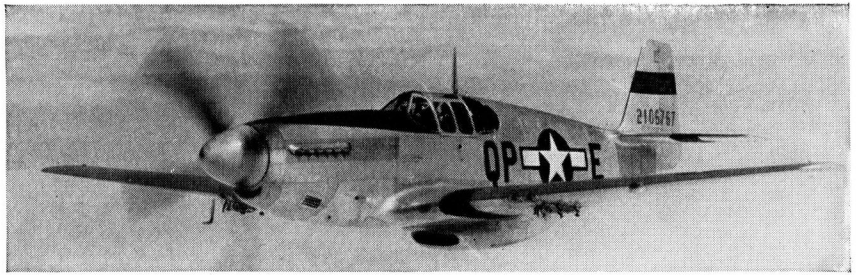


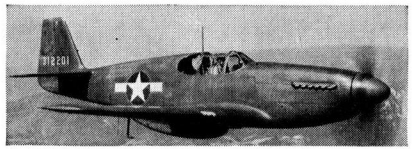
(Above) Mustang X (AM208) with Merlin 65 and (below) AL975 with Merlin 61.



in September 1942, and it was found to possess the phenomenal maximum speed of 441 m.p.h. at 29,800 ft., and it climbed to 20,000 ft. in 5.9 minutes as compared with 9.1 minutes for the P-51A. But prior to the XP-51B's first flight, General Arnold was able to report to President Roosevelt that approximately 2,200 Merlin-powered Mustangs had been ordered for the A.A.F.

By the summer of 1943, the Merlin-engined Mustang was in full-scale production at Inglewood, California, where the initial model was the P-51B-1-NA, or NA-102, and at a new plant at Dallas, Texas, where the identical P-51C-1-NT, or NA-103, was manufactured. The P-51B and C had the V-1650-3 engine initially, this being rated at 1,400 h.p. for take-off and 1,450 h.p. at 19,800 ft., and carried four 0.5-in. wing guns with 1,260 rounds. Four hundred P-51B-1-NAs and 350 P-51C-1-NTs were followed by 800 P-51B-5-NAs, all powered by the V-1650-3, the last 550 P-51B-5s becoming B-7s upon the addition of a 70.7 Imp. gal. fuselage tank which raised total internal fuel capacity to 224 Imp. gal. This modification was also made in the field to earlier P-51Bs and Cs. With the introduction of the P-51C-5-NT onto the





(*Left*) *A P-51B-1-NA Mustang and* (*above*) *a P-51B-15-NA.*

assembly line at Dallas, the V-1650-7 engine was adopted as standard, this offering 1,450 h.p. for take-off and a war emergency rating of 1,695 h.p. at 10,300 ft., maximum speed at 30,000 ft. being reduced from 440 to 435 m.p.h. but increased from 430 to 439 m.p.h. at 25,000 ft. Three hundred and ninety-eight P-51B-10-NAs, 390 P-51B-15-NAs, and 1,350 P-51C-10-NAs were also manufactured with the V-1650-7 engine, bringing the total number of P-51Bs built at Inglewood to 1,988 and P-51Cs built at Dallas to 1,750, production at both plants subsequently switching to the P-51D.

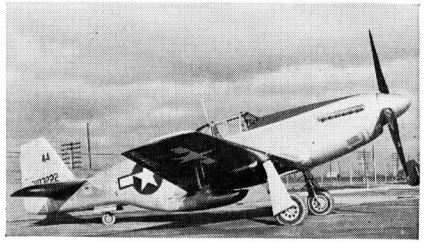
The first P-51B Mustangs were delivered to the U.S. 8th Air Force in the United Kingdom on December 1, 1943, and with two 62.5 or 125 Imp. gal. drop tanks, flew their first long-range escort mission on December 13th—490 miles to Kiel and back. In March 1944 P-51Bs and Cs accompanied B-17 Fortress and B-24 Liberator bombers all the way on the 1,100-mile round trip to Berlin, much to the surprise and consternation of the Luftwaffe, upon which they imposed a severe tactical problem. In the early months of 1944 P-51Bs also began operations in Burma in support of airborne troops attacking Japanese lines of communication, and were introduced in the 15th Air Force in Italy.

Two hundred and seventy-four P-51Bs and 636 P-51Cs were supplied to the R.A.F., by whom they were operated as Mustang IIIs, the first R.A.F. unit to operate the Mustang III being No. 19 Squadron at Ford in February 1944. Supplied under Lend-Lease, these P-51Bs and Cs arrived in the United Kingdom with their original sideways-hinging and close-fitting cockpit canopy, but the restricted rearward view was unacceptable to the R.A.F., and a bulged, sliding frameless hood was therefore designed by R. Malcolm and fitted to most Mustang IIIs as well as a number of A.A.F. P-51Bs and Cs. Tactical reconnaissance

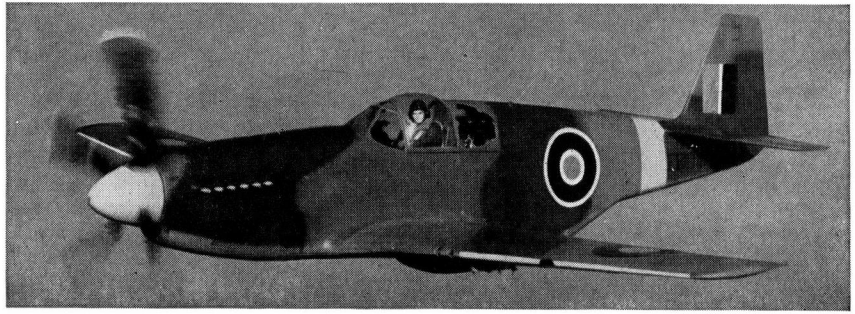
variants included seventy-one **P-51B-10-NAs** and twenty P-51C-10-NTs which were modified as F-6Cs and carrying two K-17, K-22 or K-24 cameras in the rear fuselage.

The following specification relates to the P-51B-1-NA, figures in parentheses relating to the P-51C-10-NT.

Type: *Single-seat Interceptor, Long-range Escort Fighter and Fighter-bomber.* **Power Plant:** *One* 1,620 (1,695) *h.p. Packard V-*1650-3 (-7) *Merlin twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Four* 0.5-*in. Browning MG* 53-2 *machine guns with* 350 (*inboard pair*) *and* 280 (*outboard pair*) *r.p.g. plus two* 1,000-*lb. bombs.* **Performance:** *Maximum speed,* 388 (395) *m.p.h. at* 5,000 *ft.,* 406 (417) *m.p.h. at* 10,000 *ft.,* 427 (426) *m.p.h. at* 20,000 *ft.,* 430 (439) *m.p.h. at* 25,000 *ft.,* 440 (435) *m.p.h. at* 30,000 *ft.; range on internal fuel,* 550 (955) *mls. at* 343 (397) *m.p.h. at* 25,000 *ft.,* 810 (1,300) *mls. at* 253 (260) *m.p.h. at* 10,000 *ft.,* (*with maximum external fuel*), 2,200 (2,440) *mls. at* 244 (249) *m.p.h.; time to* 5,000 *ft.,* 1.8 (1.6 *min., to* 10,000 *ft.,* 3.6 (3.1) *min., to* 20,000 *ft.* 7 (6.9) *min.; service ceiling,* 42,000 (41,900) *ft.* **Weights:** *Empty,* 6,840 (6,985) *lb.; normal loaded,* 9,200 (9,800) *lb.; maximum,* 11,200 (11,800) *lb.* **Dimensions:** *Span,* 37 *ft.* 0¼ *in.; length,* 32 *ft.* 3 *in.; height,* 8 *ft.* 8 *in.; wing area* 233 *sq. ft.*

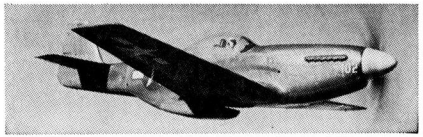


(*Above, right*) *A P-51C-1-NT and* (*below*) *a Mustang III with a Malcolm hood.*



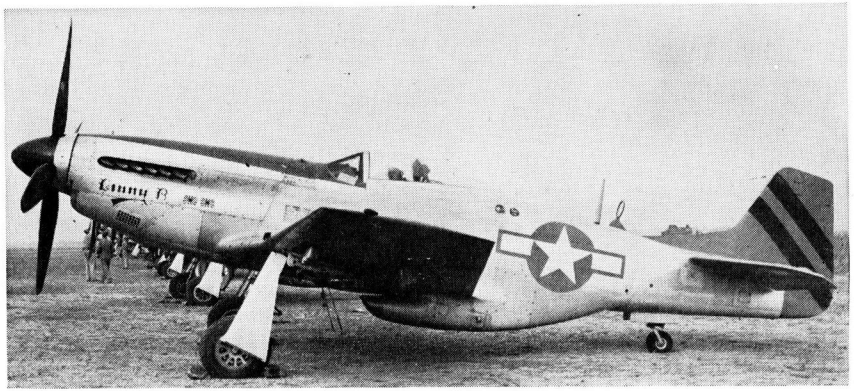
NORTH AMERICAN P-51D & P-51K MUSTANG U.S.A.

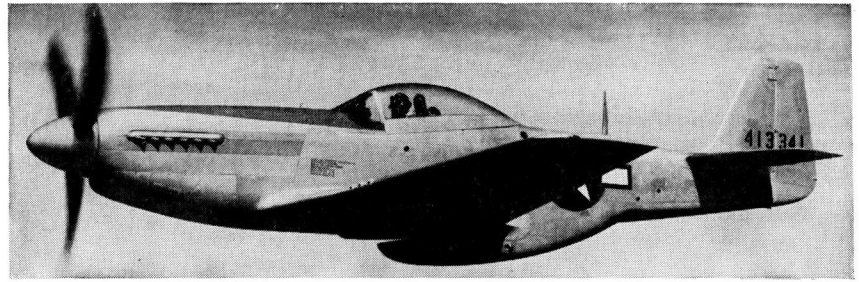
The concern expressed by the R.A.F. about the Mustang's rearward view, which had resulted in the Malcolm hood, was echoed by the A.A.F. The Malcolm hood was merely a temporary measure and a beautifully streamlined all-round-vision bubble-type canopy had been designed and was under test on a modified P-51B-1-NA. The decision was taken to introduce this new canopy on the production lines, together with other refinements, and two P-51B-10-NA airframes were extracted from the Inglewood line and completed as NA-106s with cut-down rear fuselage, bubble-type canopy, provision for six wing-mounted 0.5-in. guns and 1,880 rounds and more minor refinements. These, designated P-51Ds, were the immediate predecessors of the P-51D-5-NA, the first production model to feature the bubble canopy. Four P-51D-1-NA Mustangs had been completed with the original type canopy before the first -5-NA model, or NA-109, left the line, and the P-51D was to become the most widely produced variant of all Mustangs, 6,502 P-51D-5-NA to -25-NA Mustangs being delivered from Inglewood, and 1,454 P-51D-5-NT to -20-NT Mustangs from Dallas.



The P-51D Mustang was rapidly delivered to A.A.F. squadrons in both Europe and the Pacific, and this type was destined to under-

(Left) A P-51B-1-NA used to test "bubble" canopy and (below) a P-51K in China.





An early production P-51D-5-NA Mustang prior to the introduction of the dorsal fin.

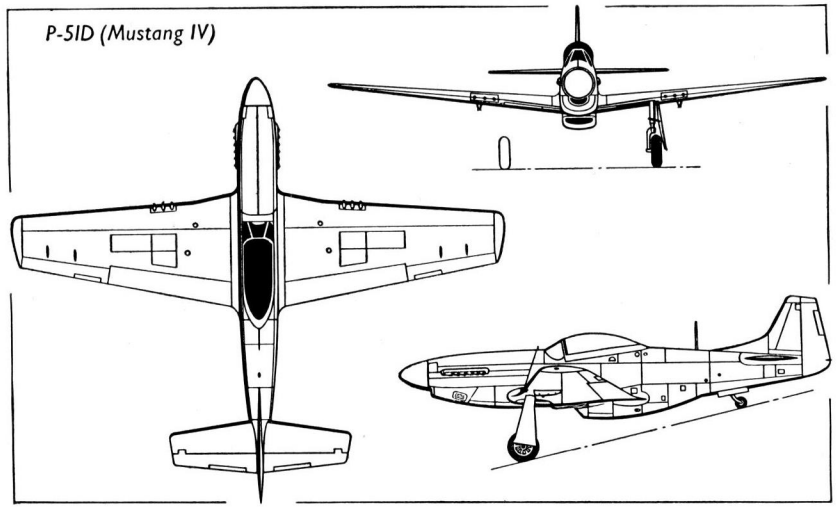
take the first land-based fighter strikes against Tokyo on April 7, 1945. High-altitude escort and combat remained the Mustang's forte, however, and the P-51D possessed a marked edge in speed and manoeuvrability over all Luftwaffe piston-engined fighters above 20,000 ft. As production got into its stride a dorsal fin was introduced to compensate for the loss of keel surface resulting from the cutting down of the rear fuselage, and the underwing racks were augmented by twin zero-length launching stubs for 5-in. rocket missiles on the last 1,100 P-51D-25-NA Mustangs. Some P-51Ds in Europe had previously carried a cluster of three Bazooka-type rocket-launching tubes beneath each wing for ground-strafing sorties.

One hundred and thirty-six F-6D-20-NT to -25-NT tactical reconnaissance Mustangs were delivered from Dallas by the conversion of P-51Ds, and 1,500 P-51Ks were ordered from Dallas, 163 of these being completed as F-6Ks. The P-51K differed from the D-model solely in having an 11 ft.-diameter Aeroproducts airscrew in place of the 11 ft. 2 in.-diameter Hamilton Standard. The P-51K-1-NT and -5-NT batches were not fitted with rocket stubs, but these were introduced on the -10-NT and subsequent batches. Two hundred and eighty-one P-51Ds were supplied to the R.A.F. as Mustang IVs together with 594 P-51Ks which received a similar designation. Three hundred and fourteen P-51Ks were allocated to the R.A.A.F., but in February 1944, prior to the delivery of these aircraft, the Australian Commonwealth Aircraft Corporation had begun tooling up for the licence production of the P-51D. Designated CA-17 Mustang 20, the first eighty aircraft were assembled in Australia from 100 sets of imported components, but the first of these did not fly until May 1945, and was too late, therefore, to participate in the final assault on Japan. Commonwealth Aircraft went on to build a further 120 Mustangs, the first fourteen of which were built as Mk.21s with the V-1650-7 engine, but were later modified to Mk.22 standards by the installation of F.24 cameras. These were followed by twenty-six Mk.21s, sixty-seven Mk.23s with Merlin 66 or 70 engines, and thirteen Mk.22 tactical reconnaissance aircraft. Fifty P-51Ds were supplied to the Chinese, and forty were sup-

plied to the Dutch forces operating in the Pacific.

The following specification relates to the P-51D-25-NA, other D- and K-models being generally similar.

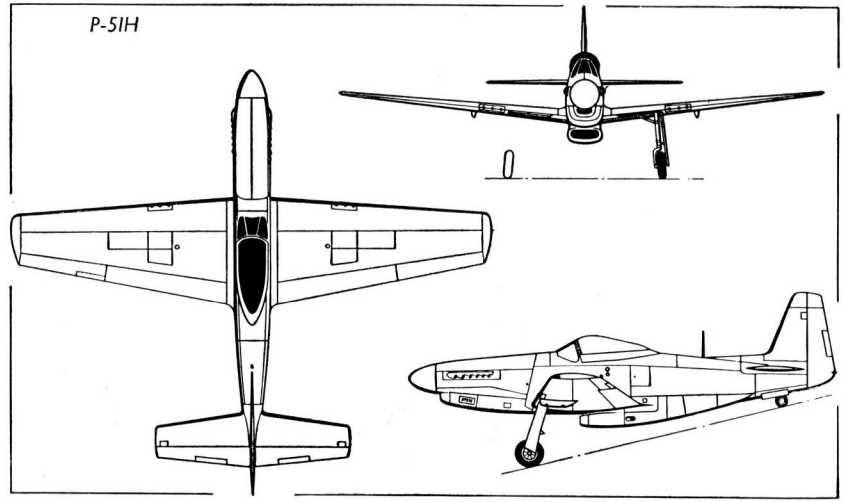
Type: *Single-seat Interceptor, Long-range Escort Fighter and Fighter-bomber.* **Power Plant:** *One* 1,695 *h.p. Packard V-*1650-7 *Merlin twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Six* 0.5-*in. Browning MG* 53-2 *machine guns with (outboard and centre pairs)* 270 *r.p.g. and (inboard pair)* 400 *r.p.g. (or four* 0.5-*in. guns with* 400 *r.p.g.) and two* 500-*lb. or* 1,000-*lb. bombs or six* 5-*in. rockets.* **Performance:** *Maximum speed,* 395 *m.p.h. at* 5,000 *ft.,* 416 *m.p.h. at* 10,000 *ft.,* 424 *m.p.h. at* 20,000 *ft.,* 437 *m.p.h. at* 25,000 *ft.; range (clean),* 950 *mls. at* 395 *m.p.h. at* 25,000 *ft.,* 1,300 *mls. at* 260 *m.p.h. at* 10,000 *ft., (with two* 91.6 *Imp. gal. drop tanks),* 1,650 *mls, at* 358 *m.p.h. at* 25,000 *ft.,* 2,080 *mls. at* 244 *m.p.h. at* 10,000 *ft.; time to* 5,000 *ft.,* 1.7 *min.,* to 10,000 *ft.,* 3.3 *min.,* to 20,000 *ft.,* 7.3 *min.; service ceiling,* 41,900 *ft.* **Weights:** *Empty,* 7,125 *lb.; normal loaded,* 10,100 *lb.; maximum,* 12,100 *lb.* **Dimensions:** *Span,* 37 *ft.* 0½ *in.; length,* 32 *ft.* 3 *in.; height,* 8 *ft.* 8 *in.; wing area,* 233 *sq. ft.*

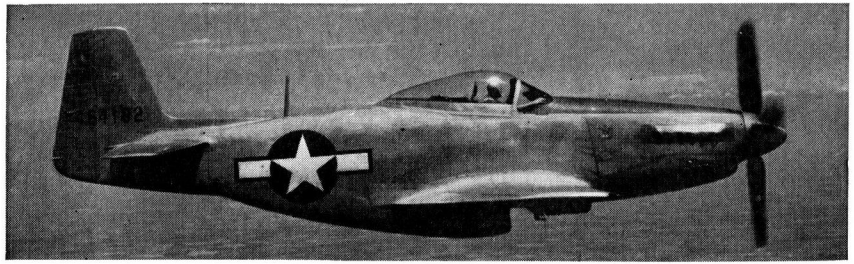


NORTH AMERICAN P-51H MUSTANG U.S.A.

The final production version of the Mustang, the NA-126 or P-51H, embodied much of the experience gained with the lightweight XP-51F and XP-51G Mustangs, and, with a V-1650-9 engine delivering a war emergency rating with water injection of 2,218 h.p. at 10,200 ft., attained a top speed of 487 m.p.h. at 25,000 ft., and was thus the fastest Mustang variant to see service.

Generally similar in appearance to the XP-51F apart from having a shorter bubble canopy, a four-blade Aeroproducts airscrew, a dorsal extension to the fin-and-rudder assembly, and an increase in overall length, it had the same shallower carburettor air intake and modified cowling, with integral engine mounting with a forty per cent weight saving over that of the P-51D, and the new low-drag wing and the simplified undercarriage with smaller wheels and new disc brakes which permitted the elimination of the broken leading edge which had characterised the wings of all earlier production Mustangs. Armament remained unchanged, alternative installations being four or six 0.5-in. guns with 1,600 rounds or 1,880 rounds respectively, and provision



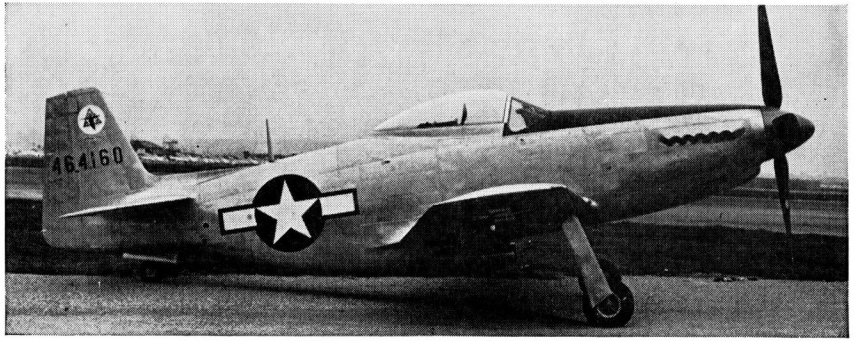


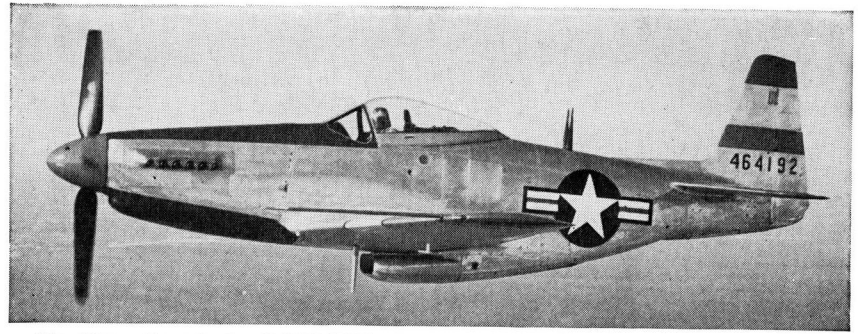
The third P-51H-5-NA (44-64182) *with interim broad chord vertical fin. This was later increased in height.*

was made for normal loads of external stores.

The first P-51H-1-NA flew on February 3, 1945, this being followed by a further nineteen -1-NA, 280 5-NA and 255 -10-NA Mustangs, the production batches incorporating minor equipment revisions and enlarged vertical tail surfaces and, too late to participate in operations over Europe, the type re-equipped a number of fighter groups in the Pacific in time to take part in the last stages of the conflict against the Japanese. V-J Day resulted in the cancellation of 1,445 P-51H

The first of twenty P-51-H-1-NA Mustangs (44-64160) *with original D-model vertical tail surfaces.*





The thirteenth production P-51H-5-NA Mustang with the taller tail surfaces subsequently standardised.

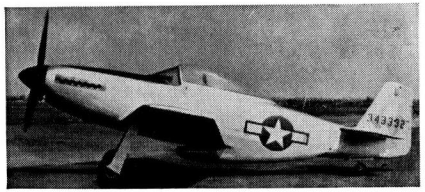
Mustangs and 1,700 P-51Ls which were to have been similar apart from the use of the more powerful V-1650-11 engine. The Dallas-built version of the P-51H was the P-51M with the V-1650-9A engine, but only one of the 1,628 fighters of this type ordered was completed before the end of the war with Japan and the cancellation of the remainder. One P-51H Mustang was supplied to the R.A.F. for evaluation.

The P-51H brought development of the Mustang to its peak, and was probably the fastest production piston-engined fighter of any of the combatants to see operational service. The Mustang created records from the day of its conception, and the rapid genealogical processes through which it passed were phenomenal by any standard. A total of 14,819 Mustangs of all types was built in the U.S.A., and in the European theatre alone this type was credited with the destruction of 4,950 enemy aircraft in combat and a further 4,131 on the ground during 213,873 sorties in A.A.F. service.

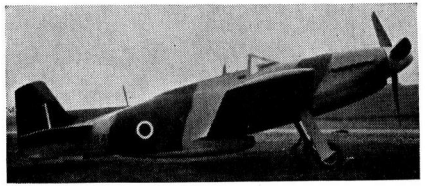
The following specification relates to the P-51H-5-NA.

Type: *Single-seat Long-range Fighter and Fighter-bomber.* **Power Plant:** *One* 2,218 *h.p. Packard V-*1650-9 *Merlin twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Six* 0.5-*in. Browning MG* 53-2 *machine guns with (outboard and centre pairs)* 270 *r.p.g. and (inboard pair)* 400 *r.p.g. (or four* 0.5-*in. guns with* 400 *r.p.g.) plus two* 500-*lb. or* 1,000-*lb. bombs or six* 5-*in.* rockets. **Performance:** *Maximum speed,* 444 *m.p.h. at* 5,000 *ft.,* 463 *m.p.h. at* 15,000 *ft.,* 487 *m.p.h. at* 25,000 *ft.; range (clean),* 755 *mls. at* 359 *m.p.h. at* 10,000 *ft.,* 1,075 *mls. at* 239 *m.p.h. at* 10,000 *ft., (with two* 62.5 *Imp. gal. drop tanks),* 1,150 *mls. at* 339 *m.p.h. at* 10,000 *ft.,* 1,530 *mls. at* 243 *m.p.h. at* 10,000 *ft.; time to* 5,000 *ft.,* 1.5 *min., to* 15,000 *ft.,* 5 *min.; service ceiling,* 41,600 *ft.* **Weights:** *Empty,* 6,585 *lb.; normal loaded,* 9,500 *lb.; maximum,* 11,500 *lb.* **Dimensions:** *Span,* 37 *ft.* 0 *in.; length,* 33 *ft.* 4 *in.; height,* 8 *ft.* 10 *in.; wing area,* 235 *sq. ft.*

NORTH AMERICAN XP-51F, G & J MUSTANG U.S.A.

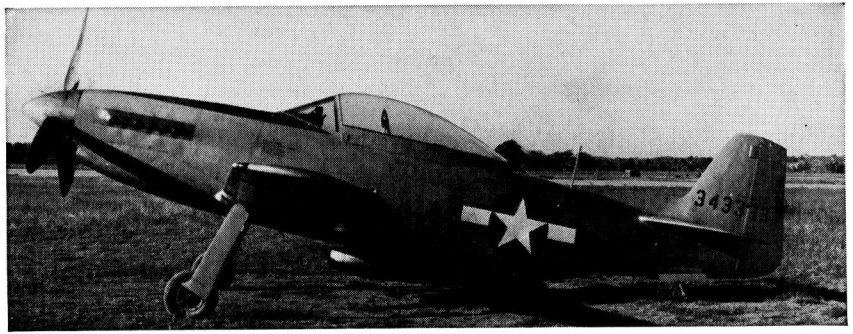


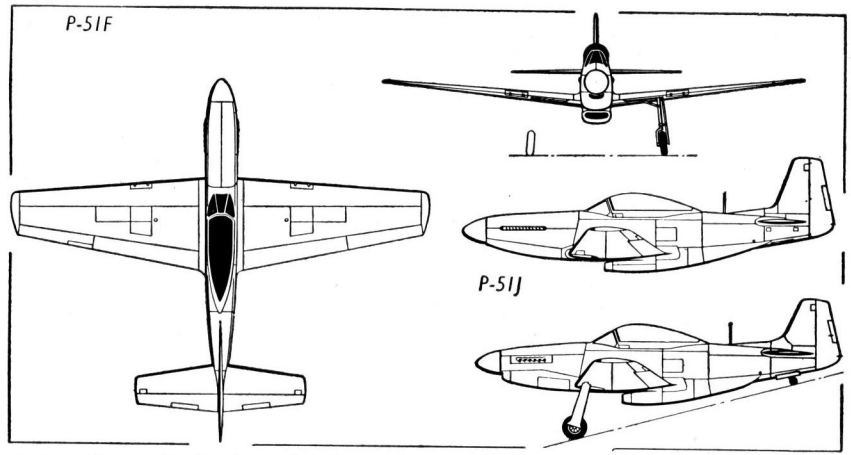
(*Above*) *The first XP-51F Mustang.*



Although the success of the Mustang was already assured, in January 1943 North American submitted their proposals to the A.A.F. for a fighter similar to P-51s then in production but designed to British load factors, giving an extremely light, high-performance aircraft. This design was modified to provide a lower ultimate load factor than standard and, designated NA-105 by the manufacturers, two prototypes were ordered under the designation XP-51F, the contract being amended in June 1943 to cover the purchase of five XP-51Fs with V-1650-3 engines, the last two of which were subsequently to be converted as XP-51Gs with Merlin 145M engines to be obtained from the United Kingdom under reverse Lend-Lease. A request by the Technical Command for the procurement of twenty-five service test P-51Fs was not authorised as it was considered that prototype trials should first be made before

(*Below*) *The second XP-51F and* (*left*) *the third XP-51F.*

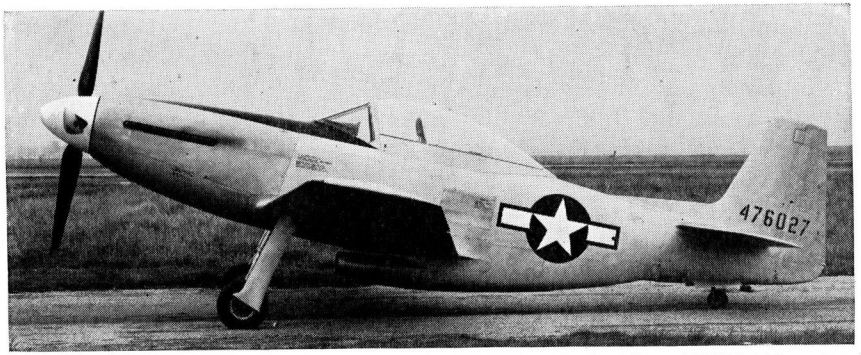




any quantity production be undertaken. The British Air Commission requested two of the lightweight fighters for evaluation and was allocated one XP-51F and one XP-51G.

The V-1650-3 was supplanted by a -7 engine while the XP-51F Mustangs were under construction. An extensive redesign of the basic airframe was undertaken in which weight was substantially reduced through the simplification of the structure, the deletion of some equipment, and the use of new materials, including plastics. A new low-drag wing was employed, and by fitting smaller wheels, with the new disc brakes, to a simplified undercarriage, the broken leading-edge that had characterised the Mustang's wing until that time was eliminated. To reduce drag, a longer bubble canopy was fitted, together with a modified radiator fairing, the oil cooler being replaced by a heat exchanger. The fuel system was redesigned around two 87 Imp. gal. wing tanks, while more weight was saved with the three-bladed Aeroproducts hollow-steel airscrew.

Engineering inspections were held in February 1944, during which a complete power plant change was undertaken by eight men, the removal taking thirteen minutes and the reinstallation taking 30.5 minutes. The first XP-51F was flown on February 14, 1944, and the second and third machines flew on May 20th and 22nd. The third XP-51F was shipped to the United Kingdom on June 30, 1944 after preliminary check flights. Work on the conversion of the fourth and fifth NA-105 airframes as XP-51Gs began in January 1944, the Merlin 145M engines arriving during the following month. Five-blade airscrews were



The final lightweight version of the Mustang, the XP-51J, with the Allison V-1710-119 engine.

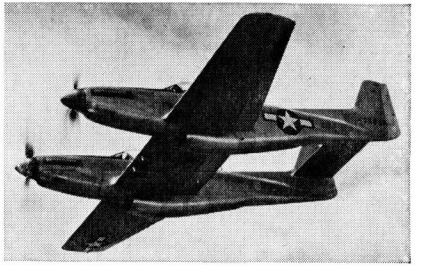
fitted but otherwise the XP-51Gs were externally similar to the XP-51Fs, and the first machine flew on August 9, 1944, the second machine following on November 14th, this aircraft being shipped to the United Kingdom in February 1945.

In the meantime, work had begun on two further lightweight NA-105 prototypes; these, designated XP-51Js, were similar to the F- and G-models except for the Allison V-1710-119 engine which gave 1,500 h.p. for take-off and 1,720 h.p. with water injection at 20,700 ft. The XP-51J had its carburettor air intake incorporated in the ventral radiator, and the first machine was flown on April 23, 1945, but the engine was insufficiently developed to permit full-power operation, and the aircraft was loaned to Allison for engine development work. The second XP-51J was not flown and was utilised by Allison for spare parts for the first machine. The XP-51J weighed 6,030 lb. empty and 7,550 lb. in normal loaded condition. A maximum speed of 491 m.p.h. was anticipated at 27,400 ft., but this was never attained under test.

The specification relates to the XP-51F, figures in parentheses relating to the XP-51G.

Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 1,695 (1,910) *h.p. Packard V-*1650-7 (*Rolls-Royce*) *Merlin* (145*M*) *twelve-cylinder Vee liquid-cooled engine.* **Armament:** *Four* (*six*) 0.5-*in. Browning MG* 53-2 *machine guns.* **Performance:** *Maximum speed,* 466 (472) *m.p.h. at* 29,000 (20,750) *ft.; cruising speed at maximum continuous power,* 379 (315) *m.p.h.; climb to* 19,500 (20,000) *ft.,* 4.9 (3.4) *min.; service ceiling,* 42,500 (45,700) *ft.; normal range,* 650 (485) *mls.; maximum range,* 2,100 (1,865) *mls.* **Weights:** *Empty,* 5,635 (5,750) *lb.; normal loaded,* 7,610 (7,265) *lb.; maximum,* 9,060 (8,885) *lb.* **Dimensions:** *Span,* 37 *ft.* 0¼ *in.; length,* 32 *ft.* 2¾ *in.; height,* 8 *ft.* 8 *in.; wing area,* 233 *sq. ft.*

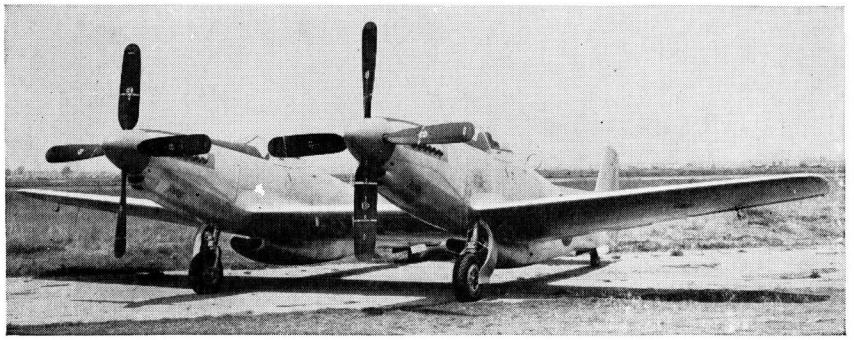
NORTH AMERICAN XP-82 TWIN MUSTANG U.S.A.

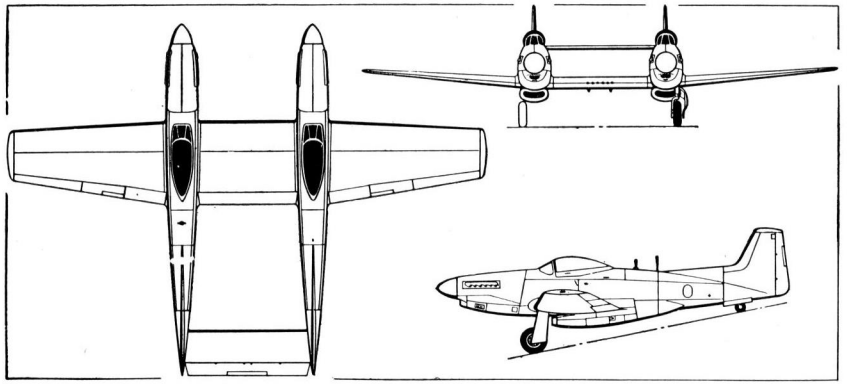


Designed for ultra long-range escort duties and destined to be the last piston-engined fighter ordered by the U.S.A.A.F., the Twin Mustang was conceived late in 1943 when it was realised that the very long distances over which single-seat fighters were operating in the Pacific imposed a tremendous strain on the pilot. Basically, the idea was to join two Mustang fuselages by a constant-chord wing centre section and a rectangular tailplane, using standard port and starboard outer wings, the port cockpit housing the pilot with full flight and engine instruments, and the starboard cockpit housing the co-pilot with sufficient instrumentation for control of the aircraft.

Designated XP-82, work on the Twin Mustang began in January 1944. The fuselages were essentially similar to that of the P-51H but were lengthened by additional sections with integral dorsal fins which were inserted in front of the tailplane. Packard

(Above, right and below) The XP-82 Twin Mustang (44-83887) *which flew on April* 15, 1945. *The twin fuselages of the XP-82 were essentially similar to the fuselage of the P-51H, but additional sections were inserted in front of the tailplane.*





V-1650-23/35 Merlin engines were fitted with opposite rotating airscrews, each main undercarriage leg was attached to the front spar under the outboard side of each fuselage, the wheel retracting inwards under the fuselage and wing, and an armament of six 0.5-in. guns was inserted in the new wing centre section.

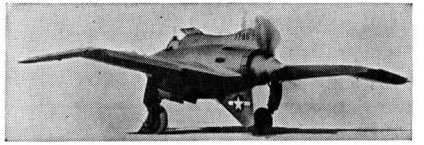
The first of two XP-82s was flown on April 15, 1945, by which time five hundred production P-82B Twin Mustangs had been ordered, these being essentially similar to the XP-82s and having wing racks for four 1,000-lb. bombs, two 2,000-lb. bombs, twenty-five 5-in. rockets, or a central pod containing eight additional 0.5-in. guns and their ammunition. The third prototype, the XP-82A, was fitted with Allison V-1710-119 engines with airscrews rotating in the same direction, but the end of the war resulted in the cancellation of 480 P-82Bs, two of the remaining twenty subsequently being completed as experimental night fighters, one being designated P-82C with SCR-720 radar, and the other P-82D with APS-4. Post-war developments included the F-82E day fighter-bomber and the F-82F and G night fighters.

Type: *Two-seat Long-range Escort Fighter and Fighter-bomber.* **Power Plants:** *Two* 1,860 *h.p. Packard V-*1650-23/25 *twelve-cylinder Vee liquid-cooled engines.* **Armament:** *Six* 0.5-*in. Browning MG* 53-2 *machine guns with* 300 *r.p.g. plus two* 2,000-*lb. or four* 1,000-*lb. bombs, or twenty-five* 5-*in. rockets.* **Performance:** *Maximum speed,* 482 *m.p.h. at* 25,100 *ft.; normal range* 1,390 *mls. at* 227 *m.p.h., (with* 4,000-*lb. bomb load),* 1,280 *mls.; time to* 20,000 *ft.,* 7 *min.; service ceiling,* 41,600 *ft.* **Weights:** *Empty,* 13,405 *lb.; normal loaded,* 19,100 *lb.; maximum,* 22,000 *lb.* **Dimensions:** *Span,* 51 *ft.* 3 *in.; length,* 38 *ft.* 1 *in.; height,* 8 *ft.* 2 *in.; wing area,* 408 *sq. ft.*

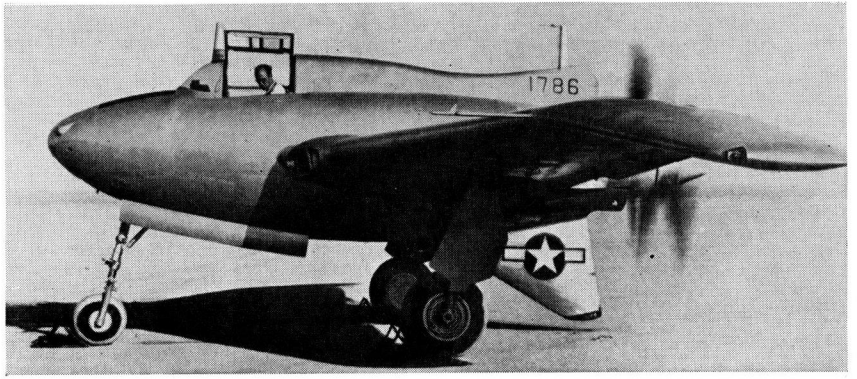
NORTHROP XP-56 — U.S.A.

One of the most radical American wartime experimental fighters was Northrop's Model N2B, or XP-56, a unique tailless interceptor built entirely of magnesium. Conceived in 1939, the N2B was designed around the projected Pratt and Whitney X-1800 liquid-cooled engine which, installed as a pusher, was to drive contra-rotating airscrews. Engineering studies were ordered on June 22, 1940, and a prototype was ordered as the XP-56 on September 26th, but shortly after development began, Pratt and Whitney requested authority to abandon further work on the X-1800 engine. Although Northrop's design team felt that the alternative Pratt and Whitney R-2800 air-cooled engine was not entirely suited to the design, on July 21, 1941, it was decided that the R-2800-29 should be installed.

In the meantime, flight trials with the N1M, which, powered by two small Lycoming engines, had an essentially similar wing to that of the XP-56 fighter, had confirmed the stability of the radical configuration about all three axes, and, realising the impracticability of having only one prototype under construction, on February 13, 1942, the U.S.A.A.F. ordered a second XP-56. Taxi trials with the



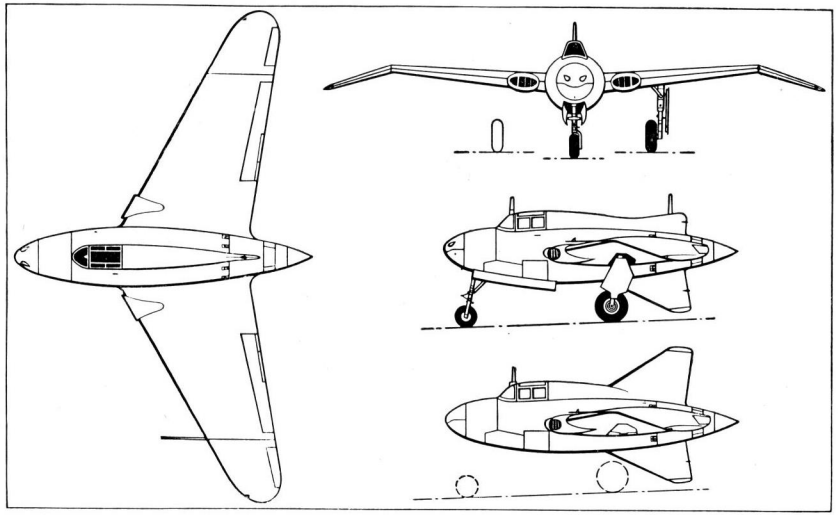
(*Above, right and below*) *The first XP-56* (41-786) *with abbreviated vertical tail surfaces.*



The extensively modified second XP-56 (42-38353) *which featured unique wingtip venturis.*

first XP-56 were undertaken in April 1943, and during these it was found that the aircraft yawed sharply and dangerously, particularly at high speed. This was believed to be due to the wheel brakes and no further trials were undertaken until the aircraft had been re-equipped with manual hydraulic brakes. Many problems with the power plant had to be overcome, and the first official flight was not made until September 30, 1943 at Muroc. An altitude of five feet was maintained and the XP-56 flew quite normally. Several further flights were made at slightly greater altitudes, but during taxi-ing the port tyre blew out and the first XP-56 was destroyed.

It was decided to re-ballast the second XP-56 and move the c.g. forward, and other changes included a major increase in the size of the upper vertical surface, and the incorporation of a novel form of rudder control which made use of air bellows to operate wingtip split flaps for directional control. The control of the bellows was achieved by valving air to or from the bellows by means of wingtip venturis. On March 23, 1944 the second XP-56 was flown for the first time, but the pilot reported that it was impossible to lift the nosewheel off the ground at speeds below 160 m.p.h., and the test lasted only seven-and-a-half minutes. The second flight was more successful, however, and the nose heaviness disappeared when the undercarriage was retracted, but only relatively low speeds could be attained. On May 30, 1944, it was decided that the N.A.C.A. should endeavour to ascertain the reasons for the XP-56's inability to attain anticipated speeds in the wind tunnel at Moffett Field. Due to priorities in effect on other projects, however, these tests were postponed until late October. While awaiting the commencement of these tests some further flight trials were undertaken, but on the tenth flight the pilot



complained of extreme tail heaviness on the ground, lack of power and excessive fuel consumption, and it was decided that further flight tests were too hazardous. After the project had been inactive for more than a year, however, the decision to abandon the project was taken.

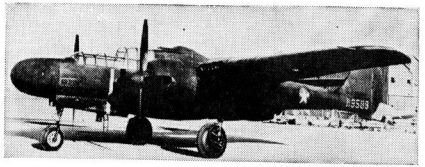
In view of the limited flight testing undertaken with the XP-56, the following specification is based on the manufacturer's estimates.

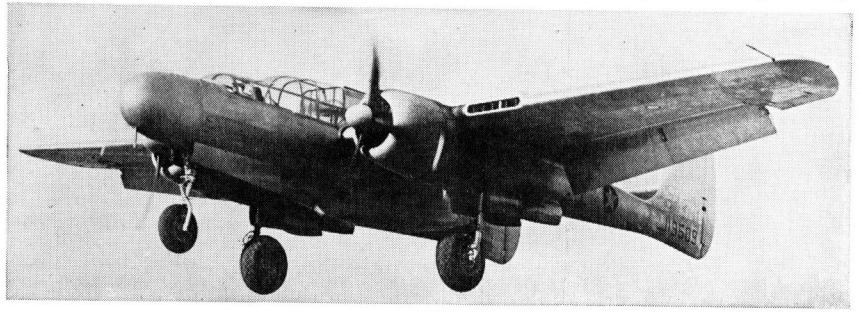
Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 2,000 *h.p. Pratt and Whitney R-2800-29 eighteen-cylinder air-cooled radial engine.* **Armament:** (*Proposed*) *Two* 20-*mm. cannon with* 100 *r.p.g. and four* 0.5-*in. machine guns with* 400 *r.p.g.* **Performance:** *Maximum speed,* 465 *m.p.h. at* 25,000 *ft.,* 417 *m.p.h. at sea level; climb rate,* 3,125 *ft./min. at* 15,000 *ft.; time to* 20,000 *ft.,* 7.2 *min.; service ceiling,* 33,000 *ft.; normal range,* 445 *mls. at* 396 *m.p.h.; maximum range,* 660 *mls.* **Weights:** *Empty,* 8,700 *lb.; normal loaded,* 11,350 *lb.; maximum* 12,145 *lb.* **Dimensions:** *Span,* 42 *ft.* 6 *in.; length,* 27 *ft.* 6 *in.; wing area,* 306 *sq. ft.*

NORTHROP P-61 BLACK WIDOW — U.S.A.

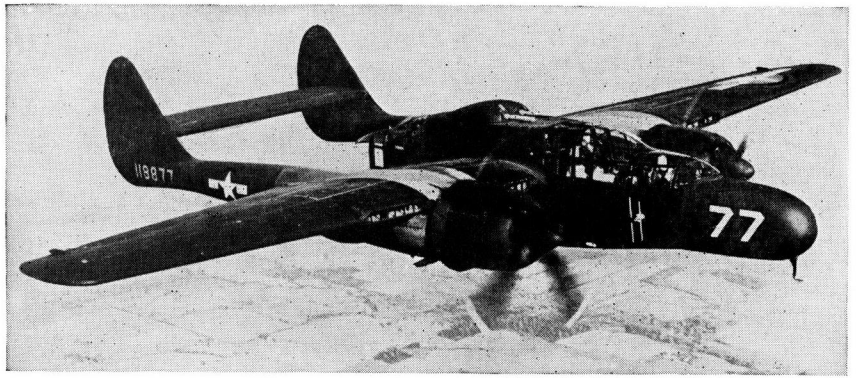
The first American aircraft to be designed from the outset for the night-fighting role, the Black Widow made its operational début in the South Pacific in the summer of 1944, and was standard night fighter equipment at the end of the war. Design of the Black Widow was initiated by Northrop in 1940 when reports from Europe indicated the need for specialised night interceptors possessing substantial endurance, radar and a heavy armament. Two prototypes were ordered on January 11, 1941, being allocated the designation XP-61, and two months later a static test model and thirteen YP-61s were ordered. The A.A.F.'s urgent need for competent night fighters prompted an order for 150 production P-61As on September 1, 1941, and on February 12, 1942, some two months before the first flight of the XP-61, production orders were increased by a further 410 aircraft.

The XP-61, which flew for the first time on May 21, 1942, was an extremely large and heavy aircraft, the central fuselage nacelle housing three crew members with the radar operator immediately behind and above the pilot and a gunner aft. Apart from a heavy fixed forward-firing armament, a remotely-controlled turret with four 0.5-in. guns was mounted above the fuselage, this normally being locked to fire forward but capable of being used as flexible defence by the gunner. The thirteen YP-61s delivered during August and September 1943, and the first thirty-seven P-61A-1-NO Black Widows, delivery of which commenced in October 1943, featured the dorsal four-gun turret, but from the outset of flight testing this turret had resulted in tail buffeting problems,





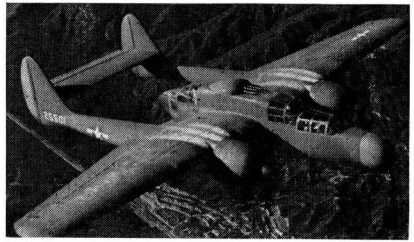
(*Left and below*) *The first XP-61* (41-19509).



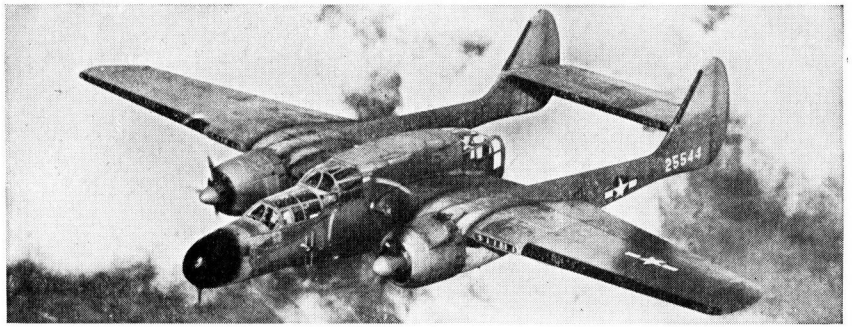
(*Above*) *The second YP-61 Black Widow and* (*below, right*) *a P-61A-1-NO with dorsal turret.*

and, in consequence, the remaining 163 P-61A-1, -5, and -10-NO Black Widows were completed as two-seaters with the turret omitted.

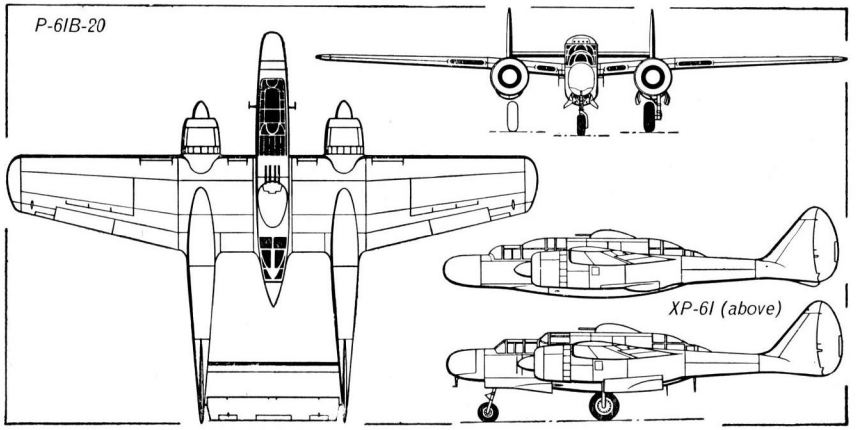
The first forty-five P-61A-1-NOs delivered retained the R-2800-10 Double Wasp engines of the XP-61 and YP-61, but the forty-sixth production machine was the first P-61A-5-NO with R-2800-65 engines having a war emergency rating of 2,250 h.p. at 1,500 ft. as compared with the maximum output of 2,000 h.p. for the -10 Double Wasp. The P-61A-11-NO was the first model of the Black Widow to be equipped with underwing fittings for two 258 Imp. gal. fuel tanks or a pair of 1,600-lb. bombs. These fittings were standardised on the P-61B-2-NO, the first B-models of the Black Widow having begun to appear in July 1944. Simultaneously, the first P-61As had arrived in the South Pacific to supplant the Douglas P-70, and had recorded their first

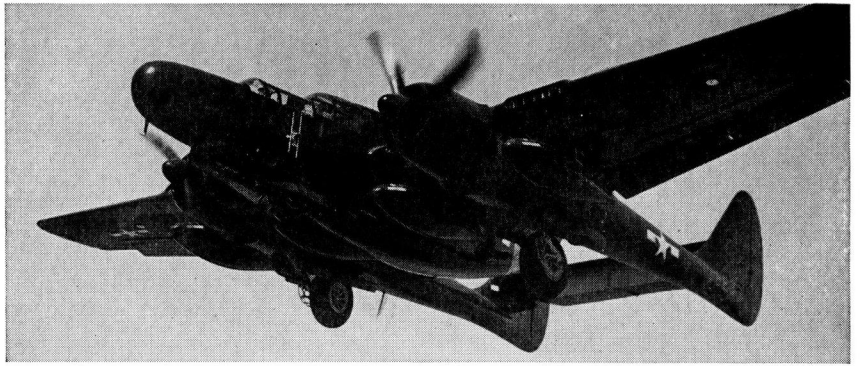


"kill" on July 7th. The P-61B-10-NO production batch introduced fittings for four 258 gal. tanks or 1,600-lb. bombs. The 201st P-61B, the first P-61B-15-NO, reintroduced the dorsal turret, the buffeting condition having been rectified, and the P-61B-20-NO featured a new General Electric turret with a redesigned fire control system.

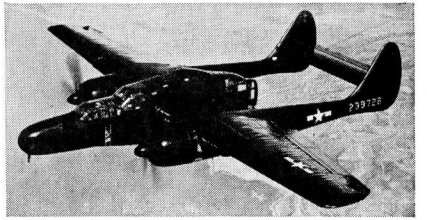


A P-61A-5-NO with the dorsal four-gun turret deleted.



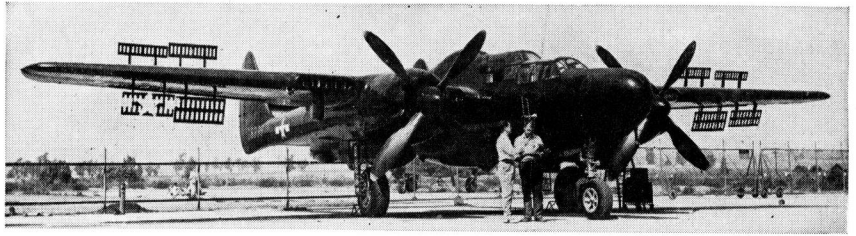


(*Above*) *The first P-61B-20-NO and* (*right*) *a P-61B-10-NO.*



Four hundred and fifty P-61B Black Widows had been completed when, in July 1945, the P-61C appeared in answer to pleas for greater speed and operational ceiling, all earlier Black Widows having proved somewhat disappointing in these respects. Turbo-supercharged R-2800-73 engines offering a war emergency rating of 2,800 h.p. endowed the P-61C-1-NO with a substantially improved performance despite further increases in weight, empty weight jumping 2,000 lb. to a record high of 24,000 lb., and normal loaded and maximum weights being raised to 30,600 and 40,300 lb. Maximum speed was increased to 430 m.p.h. at 30,000 ft., service ceiling was raised some 8,000 ft. to 41,000 ft., and an altitude of 30,000 ft. was attained in 14.6 minutes. The eighteenth production P-61C airframe was scheduled for modifications as the XP-61F, but plans to produce this model were cancelled and the aircraft was completed as a standard P-61C-1-NO, forty-one examples of which had been completed when V-J Day resulted in the termination of production and the cancellation of a further 476 machines.

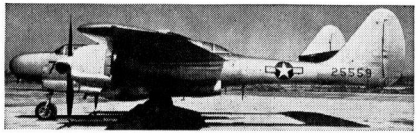
Prior to the appearance of the P-61C, two P-61As had been fitted with turbo-supercharged R-2800-77 engines for trials as XP-61Ds. The P-61G was not proceeded with and was a projected post-war development, but two P-61B airframes were modified as XP-61E long-range day fighters and flown before the

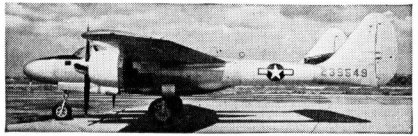


One of the forty-one P-61C-1-NO Black Widows completed before V-J Day.

end of the war. The R-2800-65 engines were retained, but the nose radar was supplanted by four 0.5-in. guns which supplemented the standard ventrally-mounted battery of 20-mm. cannon, and the two crew members were enclosed by a long, all-round-vision bubble-type canopy. Weighing 21,350 lb. empty and 31,425 lb. in normal loaded condition, the XP-61E attained a maximum speed of 376 m.p.h. at 17,000 ft., normal and maximum ranges being 2,250 and 3,750 miles. The two XP-61Es subsequently provided information for the development of the post-war F-15 Reporter reconnaissance aircraft.

The following specification relates to the P-61A-5-NO, figures in parentheses relating to the P-61B-20-NO.



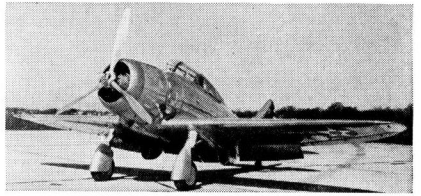


(*Above*) *The XP-61D and* (*below*) *the XP-61E.*

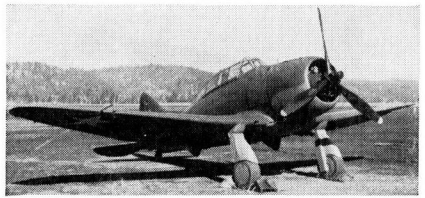
Type: *Two-*(*three*) *seat Night Fighter and Intruder.* **Power Plants:** *Two* 2,250 *Pratt and Whitney R-2800-65 Double Wasp eighteen-cylinder radial air-cooled engines.* **Armament:** *Four* 20-*mm. cannon with* 200 *r.p.g.* (*and four* 0.5-*in. guns in remotely-controlled dorsal turret with* 560 *r.p.g.*) *plus two* (*four*) 1,000-*lb. or* 1,600-*lb. bombs.* **Performance:** *Maximum speed,* 333 (330) *m.p.h. at sea level,* 355 (352) *m.p.h. at* 10,000 *ft.,* 369 (366) *m.p.h. at* 20,000 *ft.; range* (*clean*) 415 (410) *mls. at* 319 (315) *m.p.h. at* 20,000 *ft.,* 1,010 (940) *mls. at* 224 (223) *m.p.h. at* 10,000 *ft.,* (*with maximum external fuel*), 1,900 *mls. at* 221 *m.p.h. at* 10,000 *ft.; climb to* 5,000 *ft.,* 2.2 (2.7) *min.,* to 15,000 *ft.,* 7.6 (8.2) *min.; service ceiling,* 33,100 *ft.* **Weights:** *Empty,* 20,965 (21,282) *lb.; normal loaded,* 27,600 (29,700) *lb.; maximum,* 32,400 (38,000) *lb.* **Dimensions:** *Span,* 66 *ft.* 0 *in.; length,* 48 *ft.* 11 *in.; height,* 14 *ft.* 2 *in.; wing area,* 664 *sq. ft.*

REPUBLIC (SEVERSKY) P-35A — U.S.A.

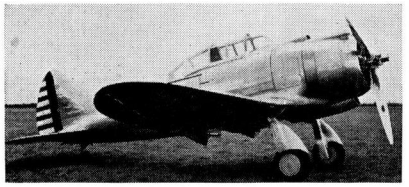
The P-35A was derived from the experimental SEV-2XP fighter monoplane designed by Alexander Kartveli of the Seversky Aircraft Corporation to participate in a competition announced by the Army Air Corps Material Division in May 1935. Designed and built with extreme rapidity, the SEV-2XP was damaged on June 18, 1935 while being ferried to Wright Field for official evaluation. At this time, it was a two-seater with a fixed, faired undercarriage, but after the accident it was returned to the Seversky factory where it was rebuilt as a single-seater with rearward-retracting main undercarriage members. Powered by an 850 h.p. Wright R-1820-G5 Cyclone single-row radial and redesignated SEV-1XP, it returned to Wright Field on August 15, 1935. During trials the SEV-1XP attained only 289 m.p.h. instead of the 300 m.p.h. at 10,000 ft. guaranteed by the manufacturers, and as the principal reason for this reduced performance was believed to be the troublesome Cyclone engine, it was re-engined with a two-row Pratt and Whitney R-1830-9 Twin Wasp of similar rating as the SEV-7. Simultaneously, new vertical tail sur-



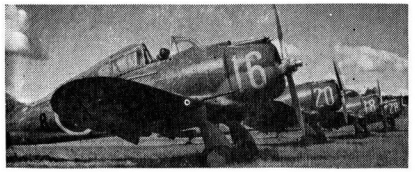
(*Above, right*) *The first production P-35* (36-354) *in its original form and* (*below*) *after modifications.*



(*Above*) *A P-35 and* (*below*) *a P-35A.*



(*Below*) *Swedish EP-106 fighters.*

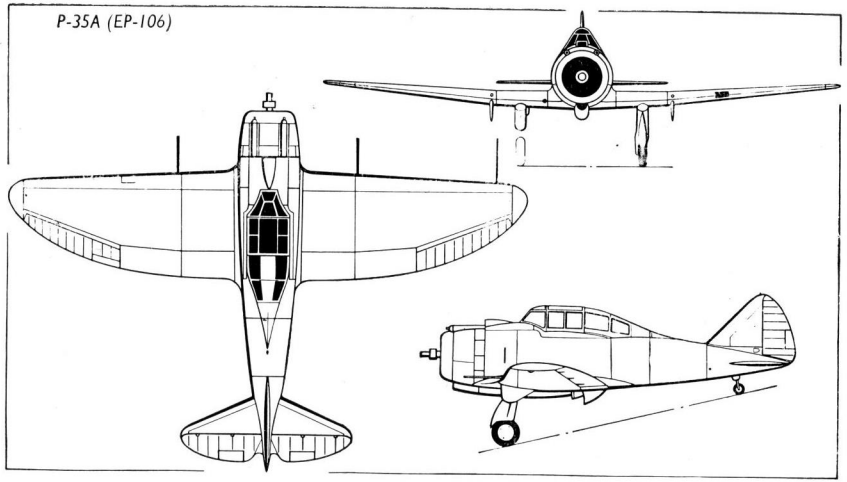


faces were adopted, but the Twin Wasp was found to yield only 738 h.p., and, in consequence, the experimental fighter's maximum speed dropped further to 277 m.p.h.

After further modifications and another change of designation (to AP-1), seventy-seven machines were ordered for the Army Air Corps as the P-35, deliveries commencing in July 1937 and terminating in August 1938. The P-35 was powered by a 950 h.p. Pratt and Whitney R-1830-9 engine and attained a maximum speed of 281 m.p.h. at 10,000 ft., a service ceiling of 30,600 ft., and an initial climb rate of 2,440 ft./min. Range with maximum fuel was 1,150 miles at 259 m.p.h., and empty and loaded weights were 4,315 lb. and 5,599 lb. respectively, while maximum loaded weight was 6,295 lb. Armament comprised one 0.3-in. and one 0.5-in. gun in the upper decking of the forward fuselage.

The last production P-35 was fitted with an R-1830-19 engine with a medium-altitude two-stage supercharger and rated at 1,200 h.p. for take-off. Overall length was increased from 25 ft. 2 in. to 27 ft. 0 in., the main undercarriage members were modified to retract inwards, and as the XP-41 the aircraft was flown in March 1939, shortly before the company changed its name from Seversky Aircraft to Republic Aviation Corporation. The XP-41 attained a maximum speed of 323 m.p.h. at 15,000 ft., cruised at 292 m.p.h., and had a maximum range of 1,860 miles. Empty and loaded weights were 5,390 lb. and 6,600 lb., and maximum overload weight was 7,200 lb., but the Army Air Corps preferred a parallel development, the high-altitude AP-4, which was eventually ordered as the YP-43.

In its export form, the P-35 was known as the EP-1, and on June 29, 1939, the Swedish government placed an order for fifteen of these fighters, following this with an order for a further forty-five on October 11, 1939, and, on January 5, 1940, placing an additional order for another sixty EP-1s, bringing total Swedish orders for the fighter to 120 aircraft. The actual model ordered by Sweden was the EP-106, and this differed from the Army Air Corps' P-35 essentially in having the more powerful R-1830-45 engine and a heavier armament. The EP-106 entered service with the Swedish *Flygvapnet* as the J 9, the first order for fifteen machines having been completed on January 18,



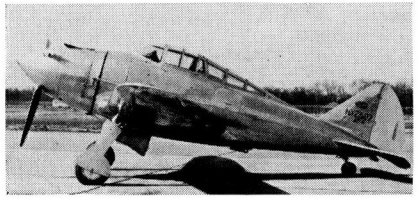
1940, and the second for forty-five machines on June 18, 1940, but the sixty machines on the third order were requisitioned by the U.S. government on October 18, 1940, and when the contract was completed on February 7, 1941, all sixty fighters were absorbed by the Army Air Corps under the designation P-35A.

Forty-eight P-35A fighters were hurriedly shipped to the Philippines where they were on strength with A.A.C. fighter units at the time of the Japanese attack. They faired badly at the hands of the Japanese fighters, however, lacking pilot protection, self-sealing fuel tanks and adequate firepower, only eight remaining airworthy after two days. The EP-106 fighters which reached Sweden served until 1944, and those P-35As not shipped to the Philippines were eventually delivered to Ecuador.

Type: *Single-seat Interceptor and Fighter-bomber.* **Power Plant:** *One* 1,050 *h.p. Pratt and Whitney R-1830-45 fourteen-cylinder radial air-cooled engine.* **Armament:** *Two* 0.3-*in. and two* 0.5-*in. machine guns plus* 350-*lb. bomb load.* **Performance:** *Maximum speed,* 310 *m.p.h. at* 14,300 *ft.; maximum cruising speed,* 260 *m.p.h. at* 10,000 *ft.; range* (108 *Imp. gal.*), 600 *mls. at* 260 *m.p.h.,* (166.5 *Imp. gal.*), 950 *mls. at* 220 *m.p.h.; initial climb rate,* 1,920 *ft./min.; service ceiling,* 31,400 *ft.* **Weights:** *Empty,* 4,575 *lb.; normal loaded,* 6,118 *lb.; maximum,* 6,723 *lb.* **Dimensions:** *Span,* 36 *ft.* 0 *in.; length,* 26 *ft.* 10 *in.; height,* 9 *ft.* 9 *in.; wing area,* 220 *sq. ft.*

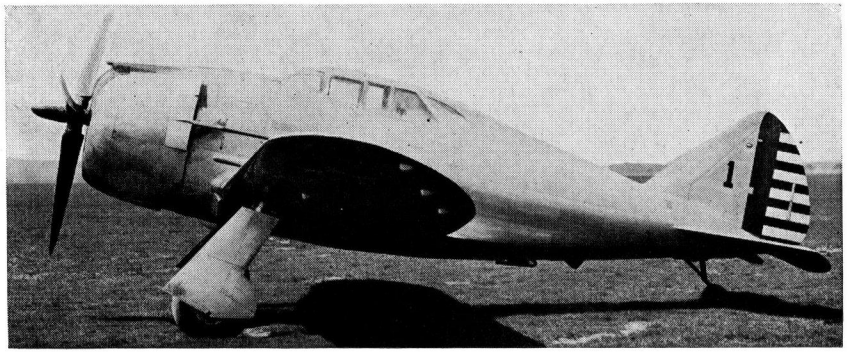
REPUBLIC P-43 LANCER — U.S.A.

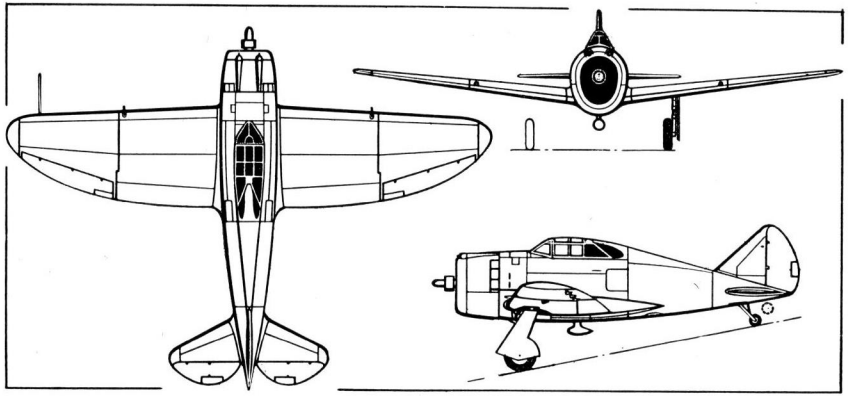
The Lancer was essentially a progressive development of the Seversky P-35, retaining the elliptical wing planform that had characterised earlier Seversky monoplanes and incorporating a fully-retractable undercarriage and flush riveting. During 1938 the Seversky company initiated work on two developments of the P-35, completing the last production machine as the XP-41 with a Pratt and Whitney R-1830-19 and integral medium-altitude two-stage supercharger, and building as a private venture the AP-4 with a similar engine and a turbo-supercharger in the rear fuselage aft of the cockpit. The airframes of both prototypes were virtually identical, and both aircraft incorporated inward-retracting main undercarriage members. Initially, the AP-4 featured a close-fitting engine cowling and an inordinately large airscrew spinner in an attempt to reduce drag, but cooling troubles necessitated switching to a more orthodox radial cowling at an early stage in the test programme, and on March 12, 1939, thirteen service test models of the AP-4 were ordered under the designation YP-43.



The YP-43 differed from the original AP-4 in a number of respects; the cockpit was

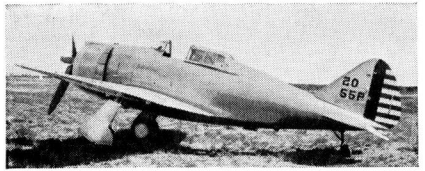
(Above, left) The first AP-4 in its original form and (below) the first YP-43 Lancer.



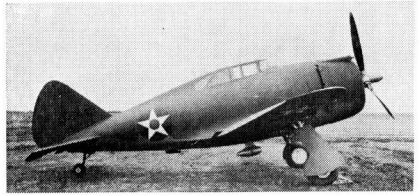


lowered as part of a drag reduction programme, the rear fuselage upper decking was raised and the transparent area aft of the pilot's seat greatly reduced, the tailwheel leg was lengthened, the turbo-supercharger intake was removed from the port wing root and mounted beneath the engine within the deeper, oval-shaped cowling, the two 0.5-in. machine guns above the engine were supplemented by a pair of wing-mounted 0.3-in. guns, and the R-1830-35 engine adopted, this offering 1,200 h.p. for take-off and 1,100 h.p. at 20,000 ft.

The first YP-43 was delivered in September 1940, a year after the Seversky Aircraft Corporation had been reorganised as the Republic Aviation Corporation, and all thirteen machines had been completed by the following April, the type being dubbed Lancer. The Lancer had already been outdated by developments in Europe, however, and on September 13, 1939, Republic had received an order for eighty examples of the more advanced AP-4J as the P-44. By the spring of 1940, combat reports from Europe indicated that even the P-44 would leave much to be desired, and Alexander Kartveli had already begun to consider its successor which was to emerge as the Thunderbolt. Eight hundred and twenty-seven more P-44s had been scheduled for production when, on September 13, 1940, all contracts for the P-44 were cancelled in favour of the P-47 Thunderbolt. At that time, no production plans for the Lancer had been formulated, but in view of the inevitable delay before R-2800 Double Wasp engines could be available and the P-47 take its place on the Farmingdale assembly lines, it now became necessary to keep the factory occupied by ordering the Lancer as a stop-gap. Thus, fifty-four P-43 Lancers were ordered with R-1830-35 engines, and the decision taken



A P-43 Lancer of the 55th Pursuit Group.



The second P-43A-1 Lancer. One hundred and eighty fighters of this type were delivered to China.

to complete the eighty P-44s ordered in 1939 as P-43As with R-1830-49 engines. As the P-44 was essentially similar to the P-43 apart from engine and equipment, the changeover from one type to the other was effected relatively easily, and delivery of the first P-43s followed immediately on the YP-43s in May 1941.

The P-43 was virtually identical to the YP-43, and the fifty-four fighters of this type were followed by the eighty P-43As, delivery of which began in September 1941. The P-43A differed in having the R-1830-49 engine which afforded its full 1,200 h.p. at 25,000 ft. Earlier, in June 1941, 125 P-43A-1s had been ordered with Lend-Lease funds for China, although their principal purpose was to ensure continuity of production at Farmingdale until deliveries of the Thunderbolt began in March of the following year. The P-43A-1 had the R-1830-57 engine with a similar rating to the -49, four 0.5-in. machine guns (two over the engine and two in the wings), improved pilot protection and self-sealing fuel tanks, and provision for a 41.6 Imp. gal. drop tank or six 20-lb. bombs.

Production of the P-43A-1 Lancer was completed in March 1942, and 108 fighters of this type were delivered to China where they saw a certain amount of action against the Japanese, although they were handicapped by poor manoeuvrability, inefficient self-sealing fuel tanks and other troubles. The P-43s and P-43As were considered unsuited for the fighter role by the U.S.A.A.F., and all were converted as P-43B reconnaissance aircraft by the installation of cameras in the rear fuselage. Conversions to P-43B standards included the P-43A-1s not included in the deliveries to China, and these were supplied to the R.A.A.F. in 1942. A total of 150 P-43B Lancer conversions was produced, and with modified camera installation, two P-43As became P-43Cs. The P-43D and P-43E were other proposed reconnaissance conversions.

The following specification relates to the P-43A-1.

Type: *Single-seat Interceptor and Fighter-bomber.* **Power Plant:** *One* 1,200 *h.p. Pratt and Whitney R*-1830-57 *Twin Wasp fourteen-cylinder air-cooled radial engine.* **Armament:** *Four* 0.5-*in. Browning machine guns and one* 200-*lb. or six* 20-*lb. bombs.* **Performance:** *Maximum speed,* 356 *m.p.h. at* 20,000 *ft.; cruising speed,* 280 *m.p.h.; time to* 15,000 *ft.,* 6 *min.; service ceiling,* 36,000 *ft.; range (with* 200-*lb. bomb),* 650 *mls.; maximum ferry range,* 1,450 *mls.* **Weights:** *Empty,* 5,996 *lb.; loaded,* 7,435 *lb.; maximum,* 8,480 *lb.* **Dimensions:** *Span,* 36 *ft.* 0 *in.; length,* 28 *ft.* 6 *in.; height,* 14 *ft.* 0 *in.; wing area,* 223 *sq. ft.*

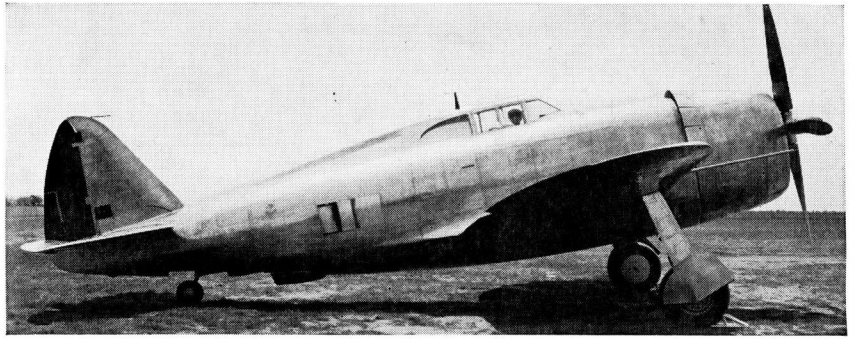
REPUBLIC P-47B–P-47C THUNDERBOLT — U.S.A.

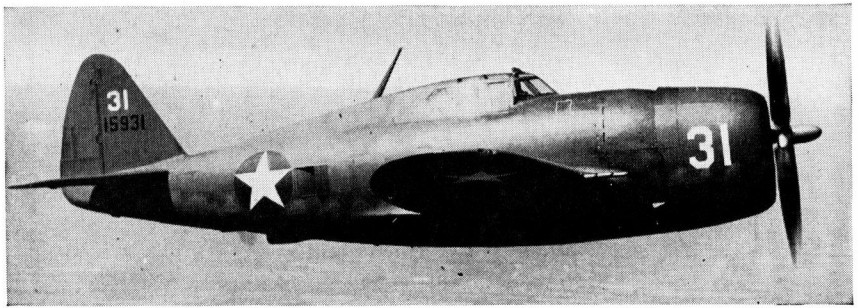
The largest and heaviest single-seat single-piston-engined fighter ever built, the Republic Thunderbolt, designed by Alexander Kartveli, represented the culmination of a continuous line of fighter development begun in 1935 with the experimental SEV-1XP built by the Seversky Aircraft Corporation. From this design had stemmed the P-35 and P-43, and in 1939 Kartveli's design team had initiated work on two new single-seat fighters, the developed AP-4 and the AP-10.

The AP-4 was being developed in two versions, the AP-4J powered by a 1,400 h.p. Pratt and Whitney R-2180 radial, eighty examples of which had been ordered on September 13, 1939 as the P-44, and the AP-4L powered by the new 2,000 h.p. Pratt and Whitney R-2800 Double Wasp. The AP-10 conformed with the official policy prevailing at the time of its conception, being a small, lightweight machine with a gross wing area of 115 sq. ft. and a gross weight of 4,900 lb., designed around a 1,150 h.p. Allison V-1710-39 liquid-cooled engine and carrying an armament of two 0.5-in. machine guns. This design had been offered to the Army Air Corps on August 1, 1939, but had not been accepted in its original form, an enlarged model being requested. Armament was increased by the addition of four wing-mounted 0.3-in. machine guns, and gross weight rose to 6,570 lb., and in this form one prototype was ordered in November as the XP-47, together with a stripped-down version designated XP-47A.

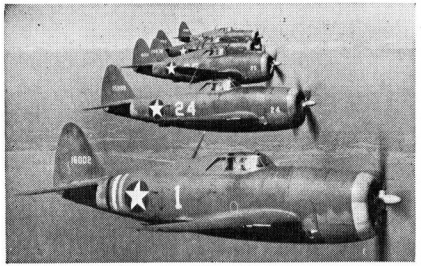
By the late spring of 1940, combat reports from Europe had clearly indicated that the performances of both fighter designs fell far short of what would probably be considered

The XP-47B which flew for the first time on May 6, 1941, *eventually being destroyed on August* 8, 1942.





(Above and below, left) The initial production model of the Thunderbolt, the P-47B.

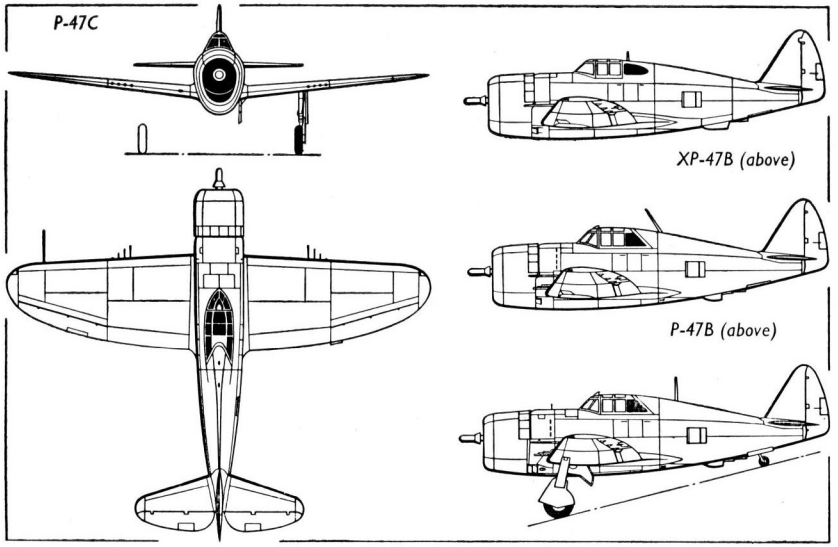


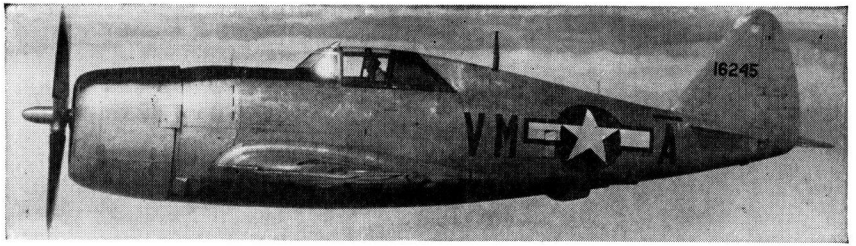
essential in the immediate future, and greater firepower, increased armour protection and self-sealing fuel tanks were vital necessities. Therefore, on June 12, 1940, Kartveli offered a new eight-gun, 11,500-lb. single-seat fighter powered by a turbo-supercharged R-2800 Double Wasp eighteen-cylinder two-row radial, proposing the abandonment of both fighters then under development. The A.A.C.'s evaluation of the new project was favourable, a prototype being ordered on September 6, 1940 as the XP-47B, the earlier XP-47 and XP-47A being cancelled. One week later the contract placed in 1939 for eighty P-44s was changed to a contract for a similar quantity of P-43 Lancers which, together with a further fifty-four P-43s, were to keep Republic Aviation's production line occupied pending the introduction of the new fighter, 773 examples of which were ordered—171 as P-47Bs and 602 as P-47Cs.

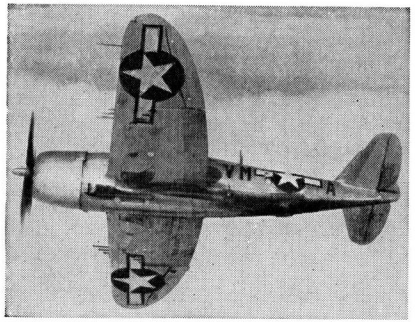
The power plant offered many problems, one of the most important of which was the need for an efficient super-charging duct system offering the least interrupted airflow. Kartveli's team therefore adopted the unorthodox method of designing this feature first and then building up the fuselage around it. The immense turbo-supercharger was stowed internally in the rear fuselage with the large intake for the air duct mounted under the engine with the oil coolers. Exhaust gases were piped back separately to the turbine and expelled through

a waste gate in the bottom of the fuselage, and ducted air was fed to the centrifugal impeller and returned, via an intercooler, to the engine under pressure. In order to utilize efficiently the power of the new R-2800 engine, a four-bladed airscrew was adopted, but in order to provide adequate ground clearance for this airscrew, a telescopic undercarriage leg had to be designed which was nine inches shorter when retracted than when extended. Many other problems had to be solved during the design stage, such as those presented by the stresses and loads which would be imposed when all eight 0.5-in. guns were fired simultaneously, and in providing the tankage necessary to accommodate the fuel loads stipulated to make this the first true single-engined strategic fighter. Thus, it was to be expected that when the first prototype, the XP-47B Thunderbolt, flew for the first time on May 6, 1941, it dwarfed all previous fighters.

Further problems presented themselves as the flight test programme progressed. It was







(*Above and below, left*) *A P-47C-2RE.*

handicapped in manoeuvrability by its size and weight, and at altitudes above 30,000 ft. the ailerons "snatched and froze", the cockpit canopy could not be opened and control loads became excessive. Blunt-nose ailerons, a jettisonable canopy and all-metal control surfaces were eventually to be fitted on production Thunderbolts to solve these problems, and balanced trim tabs were adopted to reduce rudder pedal loads. Flight trials were incomplete when, on August 8, 1942, the XP-47B was destroyed in a crash, but on the 1,960 h.p. available from the XR-2800-21 engine at 25,800 ft., a maximum speed of 412 m.p.h. had been attained. The XP-47B reached an altitude of 15,000 ft. in five minutes, and empty and normal gross weights were 9,189 lb. and 12,086 lb. respectively.

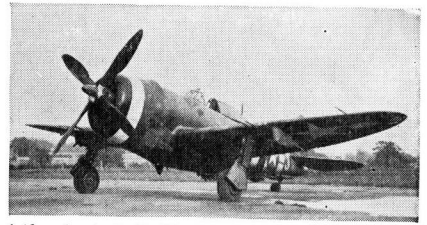
The first production P-47B Thunderbolt left the assembly line in March 1942, and differed from the prototype only in having a production-type R-2800-21 engine, metal-covered control surfaces in place of the fabric-covered surfaces, a sliding hood supplanting the hinged canopy, and a redesigned aerial mast. The first unit to receive this fighter, the 56th Fighter Group, began to re-equip in June-July 1942, and in January 1943 this group of three squadrons, followed by the 78th Fighter Group which had been similarly equipped, joined the 8th Air Force in the United Kingdom. The first operational sorties began on April 13, 1943, the Thunderbolt's first tasks being high-altitude escort duties and fighter sweeps, and although at low and medium altitudes the P-47B could not match the climb rate or manoeuvrability of the Luftwaffe fighters by which it was opposed, it could out-

dive any other fighter, this ability providing a decisive means of breaking off combat when necessary. However, the maximum internal fuel capacity of 254 Imp. gal. was insufficient to permit deep penetration into Germany.

The 171st and last P-47B airframe featured a pressurized cockpit and was redesignated XP-47E, and the 172nd production Thunderbolt produced in September 1942 was the first P-47C. Essentially similar to the initial production model, the P-47C had the forward fuselage extended eight inches at the firewall and a new engine mounting. The rudder and elevator balance system was completely redesigned, the forward-slanting radio mast was replaced by a shorter, upright mast, and overall length was increased from 35 ft. 3¼ in. to 36 ft. 1¾ in. The most important change, however, was the addition of shackles to enable a 166.5 Imp. gal. ventral drop tank to be carried. This greatly extended the Thunderbolt's radius of action, and deep penetrations by drop-tank-carrying P-47Cs of the 8th Air Force began in July 1943. The P-47C-1-RE production batch used the same R-2800-21 as the B-model, but the P-47C-5-RE had the R-2800-59 with provision for the injection of water into the intake manifold, permitting a war emergency rating of 2,300 h.p. to be obtained at 27,000 ft. Six hundred and two P-47C Thunderbolts had been delivered when, early in 1943, the improved P-47D, ordered on October 13, 1941, began to leave the assembly line.

The following specification relates to the P-47B, figures in parentheses relating to the P-47C-5-RE.

Type: *Single-seat Long-range Fighter.* **Power Plant:** *One* 2,000 (2,300) *h.p. Pratt and Whitney R-2800-21 (-59) eighteen-cylinder radial air-cooled engine.* **Armament:** *Eight 0.5-in. Browning machine guns with 267 r.p.g.* **Performance:** *Maximum speed,* 429 (433) *m.p.h. at* 27,000 (30,000) *ft.,* 340 (353) *m.p.h. at* 5,000 *ft.; initial climb rate,* 2,560 (2,780) *ft./min.; time to* 15,000 *ft.,* 6.7 (7.2) *min.; service ceiling,* 42,000 *ft.; range (clean at maximum cruise power),* 550 (640) *mls. at* 335 (350) *m.p.h. at* 10,000 *ft., (with* 166.5 *Imp. gal. drop tank),* (1,250) *mls. at* 10,000 *ft. at* (231) *m.p.h.* **Weights:** *Empty,* 9,346 (9,900) *lb.; normal loaded,* 12,245 (13,500) *lb.; maximum,* 13,360 (14,925) *lb.* **Dimensions:** *Span,* 40 *ft.* 9¾ *in.; length,* 35 *ft.* 3¼ *in.* (36 *ft.* 1¾ *in.); height,* 14 *ft.* 1¾ *in.; wing area,* 300 *sq. ft.*



(*Above*) *A P-47C-3-RE Thunderbolt. The C-model was the first version of the Thunderbolt to be built in large numbers.*

The XP-47E was the last production P-47B airframe adapted to take a pressurized cockpit. It flew for the first time in 1943.

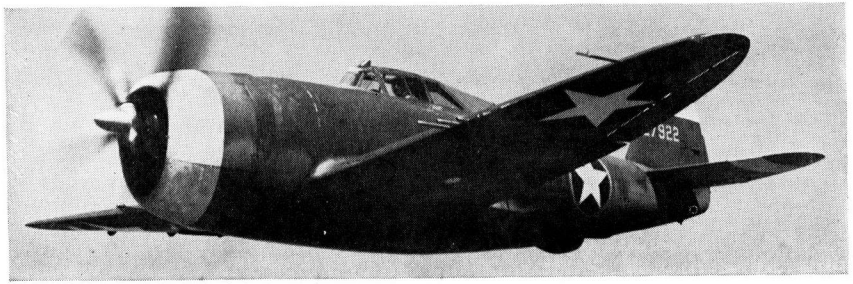
REPUBLIC P-47D–P-47G THUNDERBOLT — U.S.A.

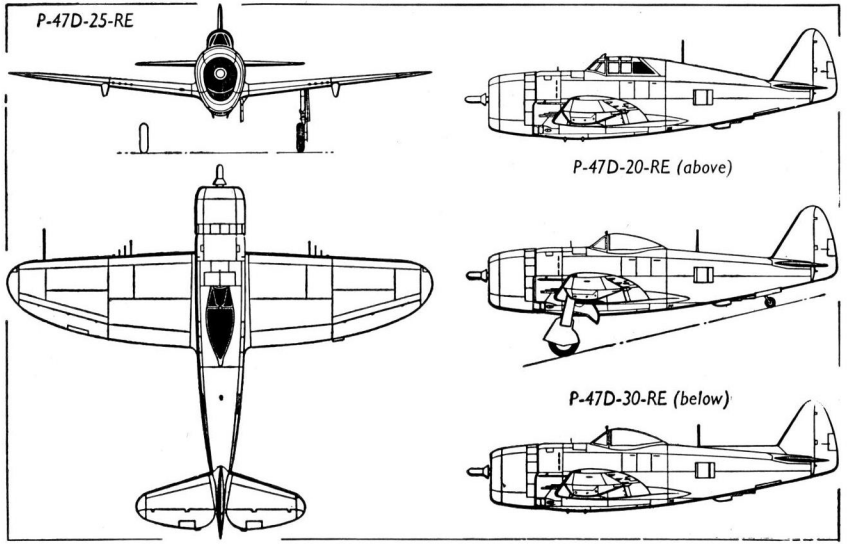
Production of the Thunderbolt really got into its stride with the P-47D which, in its early form, differed little from the P-47C-5-RE apart from changes in the turbo-supercharger exhaust system which incorporated an adjustable duct, and redesigned vents for the engine accessory section. Water injection was adopted as standard for the R-2800-21 or -59 engine, and more extensive armour protection was provided for the pilot. A new Republic factory at Evansville, Indiana, began to augment deliveries of the P-47D from the Farmingdale plant, and from December 1942 the Curtiss-Wright company began deliveries of the fighter as the P-47G, producing a total of 354 P-47G-1-CU to 15-CU Thunderbolts by March 1944, these being identical to Republic-built P-47Ds.

The P-47D was the first version of the Thunderbolt to serve with the U.S.A.A.F. in the Pacific theatre, initially operating with the 348th Fighter Group and commencing with escort missions from Brisbane, Australia. Towards the end of 1943, 8th Air Force Thunderbolts began returning from escort missions "on the deck", strafing targets of opportunity with their unused ammunition, and their success was partly responsible for the adaptation of the Thunderbolt for what was to become its most successful role—that of a fighter-bomber. The P-47D-6-RE to -11-RE and P-47G-10-CU to -15-CU production batches had only ventral shackles which could accommodate one 500-lb. bomb, but subsequent production batches were fitted with underwing pylons and, with suitable wing stiffening, were able to carry two 1,000-lb. bombs, three 500-lb. bombs or a combination of bombs and drop tanks. Either six or eight 0.5-in. guns were installed in the P-47D and P-47G, and maximum ammunition capacity had been increased to 425 r.p.g., but with the full ordnance load, the number of rounds carried was reduced to the original 267 per gun.

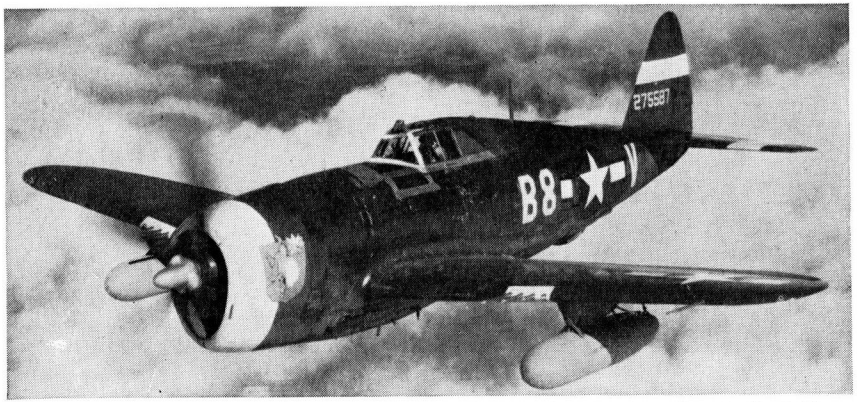
The 3,962 P-47D-1-RE to -22-RE Thunderbolts manufactured at Farmingdale, the 1,461

The P-47D-1-RE introduced water injection as standard and additional armour protection.





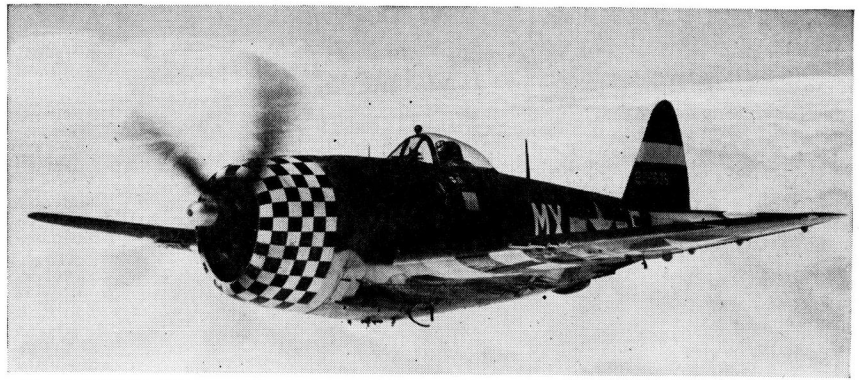
P-47-D-2-RA to -23-RA Thunderbolts produced at Evansville and Curtiss's 354 P-47G-1-CU to -15-CU Thunderbolts all possessed the original framed sliding canopy introduced on the initial production B-model, but combat experience had revealed the fact that the rear fuselage decking resulted in a 20° blind spot aft. A P-47D, redesignated XP-47K, had been completed with a cut-down rear fuselage and an all-round vision bubble-type cockpit canopy from a Hawker Typhoon, and, tested in July 1943, proved the feasibility of these modifications which were promptly introduced on the P-47D production lines. The first batches to feature this innovation were Farmingdale's P-47D-25-RE and Evansville's P-47D-26-RA. With the R-2800-59 or -63 engine, these batches employed the so-called "universal" wing which, first introduced on the P-47D-20-RE, could carry a variety of drop-tanks or bombs, and paddle-bladed airscrews of increased diameter to absorb the full war emergency power of the engine, increasing the altitude climb rate by 400 ft./min. Stronger belly shackles capable of lifting a 91.6 Imp. gal. tank were fitted; this tank, together with the



This P-47D-11-RE (42-75587) was one of several fitted with underwing pylons in the field.

170.6 Imp. gal. main fuselage tank, an 83 gal. auxiliary fuselage tank and two 125 gal. underwing tanks brought the total possible fuel load to 595 Imp. gal. and maximum range to 1,800 mls. at 195 m.p.h. at 10,000 ft.

From the P-47D-27-RE batch onwards the loss of aft keel surface resulting from the cutting down of the rear fuselage decking for the bubble canopy was rectified by the addition of a dorsal fin. The P-47D-35-RA and subsequent models had underwing zero-length launching stubs for a total of ten 5-in. rockets, and subsequent to the introduction of the bubble canopy on the -25-RE production batch the Farmingdale plant produced 2,547 P-47Ds while the Evansville plant built 4,632. The Soviet Union was allocated 203 P-47D-22-RE and -27-RE Thunderbolts under Lend-Lease, 196 of which reached their destination, eighty-eight were supplied to Brazil, one Brazilian P-47D squadron operating with the 12th Air Force in Italy from November 11, 1944, and twenty-five were supplied to Mexico to equip the Mexican Air Force's 201st Fighter Squadron which was to have served with U.S. forces in the south-west Pacific but had not left Mexico when Japan capitulated. A further 825 P-47Ds were allocated to the R.A.F., the first 240 of these having the original framed cockpit canopy and entering service as the Thunderbolt I, and the remainder, with bubble canopy, being known as the Thunderbolt II. One of the first R.A.F. units to re-equip with the P-47D was No. 5 Squadron in Burma, and other R.A.F. units operating Thunderbolts in Burma were Nos. 30, 34, 42, 60, 79, 81, 113, 123, 131, 134, 135, 146, 258, 261 and 615 squadrons. Four hundred and forty-six P-47Ds were



The P-47D-25-RE was the first model to introduce the all-round-vision bubble-type canopy.

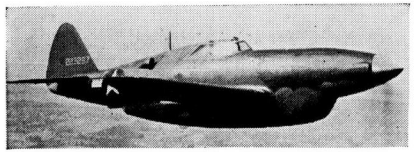
also supplied to the Free French forces, and during 1944 the Thunderbolt was operational with the U.S.A.A.F. in all active war theatres, excepting Alaska. Supplanted in the high-altitude escort role by the P-51 Mustang, it nevertheless continued to score an impressive number of "kills" against the Luftwaffe while engaged in long-range ground-attack missions, bombing and strafing communications, airfields, bridges, and troop concentrations.

The following specification relates to the P-47D-22-RE, figures in parentheses relating to the P-47D-35-RA.

Type: *Single-seat Long-range Escort Fighter and Fighter-bomber.* **Power Plant:** *One* 2,300 (2,535) *h.p. Pratt and Whitney R-2800-21 (-59) eighteen-cylinder radial air-cooled engine.* **Armament:** *Six or eight* 0.5-*in. Browning machine guns with* 267 *or* 425 *r.p.g. plus one* 500-*lb. bomb* (*two* 1,000-*lb. or three* 500-*lb. bombs or ten* 5-*in. rockets*). **Performance:** 353 (363) *m.p.h. at* 5,000 *ft.*, 406 (415) *m.p.h. at* 20,000 *ft.*, 433 (426) *m.p.h. at* 30,000 *ft.; maximum climb rate*, 2,750 (3,120) *ft./min. at* 5,000 *ft.*, 2,140 (2,650) *ft./min. at* 20,000 *ft.; time to* 10,000 *ft.*, 4.3 (4.1) *min., to* 20,000 *ft.*, 11 (8.5) *min.; service ceiling*, 40,000 (42,000) *ft.; range* (*internal fuel at maximum cruise power*), 640 (590) *mls. at* 25,000 *ft. at* 278 (310) *m.p.h.*, (*with maximum external fuel*), 925 (1,800) *mls. at* 10,000 *ft. at* 231 (195) *m.p.h.* **Weights:** *Empty*, 9,900 (10,000) *lb.; normal loaded*, 13,500 (14,000) *lb.; maximum*, 15,000 (17,500) *lb.* **Dimensions:** *Span*, 40 *ft.* 9⅜ *in.; length*, 36 *ft.* 1¾ *in.; height*, 14 *ft.* 7 *in.; wing area*, 300 *sq. ft.*

REPUBLIC XP-47E–XP-47L THUNDERBOLT U.S.A.

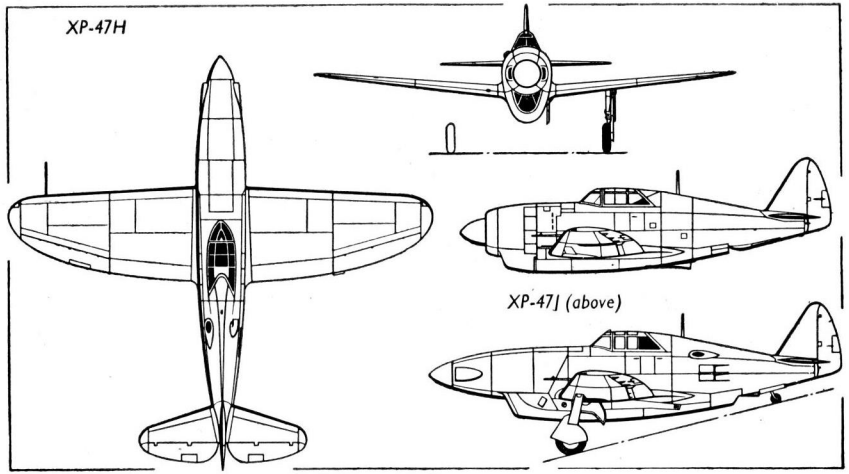
Throughout its production life, the Thunderbolt was continuously modified in the light of operational experience and was subjected to numerous experimental changes aimed at improving the basic design. Such experimental aircraft accounted for almost all suffix letters allocated from "E" to "L" inclusive, the exceptions being "G" which identified Curtiss-built P-47Ds and "I" which was not used by the A.A.F.



At a time when the Thunderbolt's principal role appeared likely to be that of high-altitude escort for B-17 Fortress and B-24 Liberator formations, the 171st and last P-47B airframe was adapted to take a pressurized cockpit, flying in 1943 as the XP-47E. Increased emphasis on low-altitude operations, however, led to the abandonment of tentative plans to introduce this equipment in production Thunderbolts, although the XP-47E contributed much information on cabin pressurization problems which proved useful in the development of other high-altitude fighters.

Another P-47B airframe served to test laminar-flow wings as the XP-47F, and in 1943 two P-47D-15-RE airframes were mated to the new 2,300 h.p. Chrysler XIV-2220-1 sixteen-cylinder inverted-vee liquid-cooled engine under the designation XP-47H. The

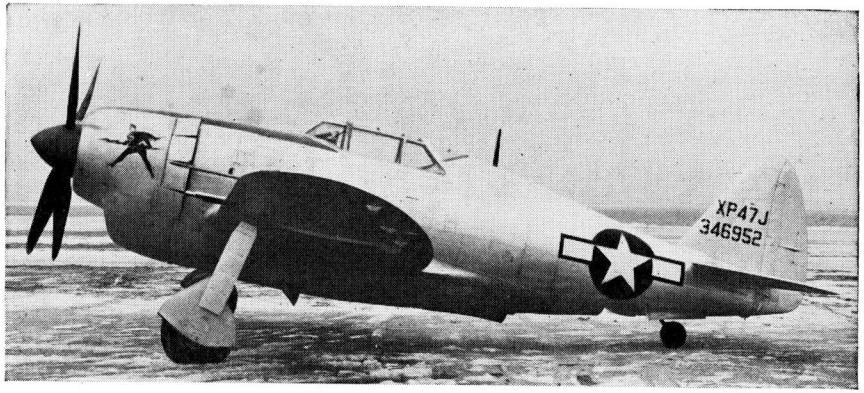
(*Above, left and below*) *The first of two XP-47H Thunderbolts* (42-23297) *with the Chrysler engine.*



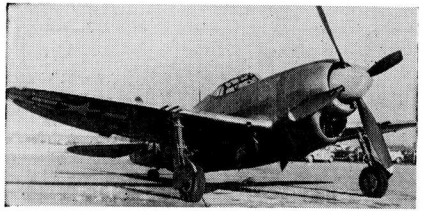
Chrysler engine radically changed the appearance of the Thunderbolt and increased overall length to 39 ft. 2 in. During flight trials, one of the XP-47H Thunderbolts attained a speed of 490 m.p.h. in level flight, but the XIV-2220 power plant did not reach production. The fastest version of the Thunderbolt was, however, the XP-47J which was first proposed in November 1942 with the aim of reducing the fighter's weight and exploring the performance limits of the basic design. The R-2800-57(C) engine was very closely cowled and fan-cooled, and there was a separate ventral intake for the CH-5 turbo-supercharger. The wing structure was lightened and the six 0.5-in. gun wing armament was installed.

The XP-47J flew for the first time on November 26, 1943, and on August 4, 1944 attained a speed of 504 m.p.h. in level flight, gaining the distinction of becoming the first airscrew-driven fighter to exceed 500 m.p.h. It was proposed at one time to produce the J-model in quantity, but Republic's development of the more advanced XP-72 resulted in tentative production plans for the P-47J being abandoned.

The XP-47K, completed on July 3, 1943, was a D-model airframe with a cut-down rear fuselage and the all-round-vision bubble-type canopy of a Hawker Typhoon. This aircraft proved the practicability of introducing such a canopy on the Thunderbolt, and this was adopted as standard on all production batches from the P-47D-25-RE. Another change



(*Above and below, left*) *The sole XP-47J Thunderbolt which attained* 504 *m.p.h. in August* 1944.



adopted on this production batch was an increase in internal fuel capacity from 254 to 308 Imp. gal., this innovation first being tested on the XP-47L, formerly a P-47D-20-RE.

The following specification relates to the XP-47J Thunderbolt.

Type: *Single-seat Long-range High-altitude Fighter.* **Power Plant:** *One* 2,800 *h.p. Pratt and Whitney R-*2800-57(C) *eighteen-cylinder radial air-cooled engine.* **Armament:** *Six* 0.5-*in. Browning machine guns.* **Performance:** *Maximum speed,* 507 *m.p.h. at* 34,300 *ft.; range,* 765 *mls. at* 400 *m.p.h.,* 1,070 *mls. at econ. cruising speed; time to* 15,000 *ft.,* 4.5 *min.; service ceiling,* 45,000 *ft.* **Weights:** *Empty,* 9,663 *lb.; normal loaded,* 12,400 *lb.; maximum,* 16,780 *lb.* **Dimensions:** *Span,* 40 *ft.* 11 *in.; length,* 33 *ft.* 3 *in.; height,* 14 *ft.* 2 *in.; wing area,* 300 *sq. ft.*

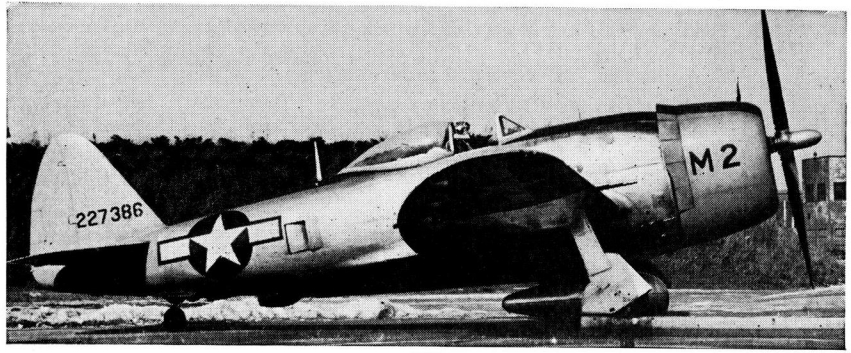
REPUBLIC P-47M–P-47N THUNDERBOLT U.S.A.

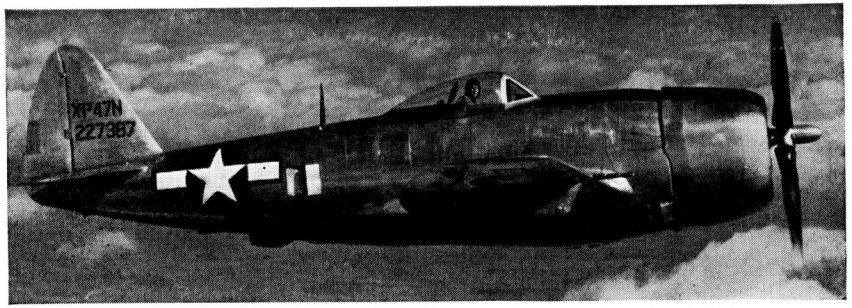
With the advent of the Fieseler Fi 103, or V-1 missile, and turbojet- and rocket-propelled fighters in Luftwaffe service, a "sprint" version of the Thunderbolt was hurriedly produced to meet the threat. Three P-47D airframes were fitted with the R-2800-57(C) and the larger CH-5 turbo-blower which, similar to the engine and blower of the high-speed XP-47J, developed a war emergency power, with water injection, of 2,800 h.p. at 32,500 ft. Air brakes were fitted beneath the wings to aid deceleration after diving on the quarry. The three converted P-47Ds were designated YP-47Ms and, proving the effectiveness of the additional power, these served as prototypes for the P-47M, 130 of which were subsequently built, these operating mostly in France after D-Day.

The second YP-47M was later fitted with a new wing with which it flew as the XP-47N in September 1944. The P-47N was the final model of the Thunderbolt and the heaviest production model of this fighter. Produced expressly for operations in the Pacific theatre, where the principal requirement was range, the P-47N employed the fuselage and engine of the P-47M married to a redesigned and strengthened wing of slightly greater span and area. The wings housed two 77.4 Imp. gal. fuel tanks for the first time, and with external tanks the maximum fuel load attained a formidable 954 Imp. gal., giving an ultimate range of 2,350 miles. A strengthened undercarriage was needed to cope with the increase in gross weight. The P-47N-5-RE and subsequent batches had zero-length rocket launchers added, and the R-2800-77 was installed in late production models, such as the P-47N-25-RE.

The P-47N gave excellent service in the Paci-

The second of three YP-47M Thunderbolts later converted as the first XP-47N.

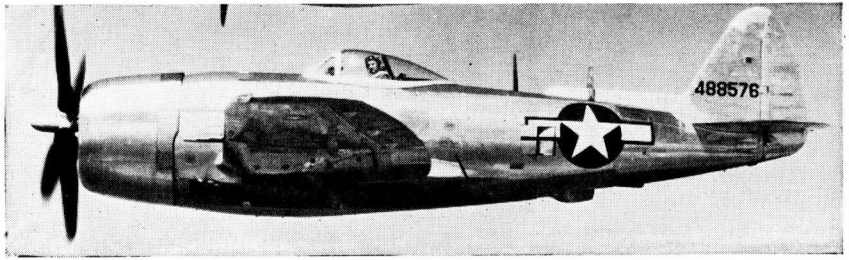




The second XP-47N, originally flown as the third YP-47M Thunderbolt.

fic, particularly in escorting B-29 Superfortresses, flying with them all the way from Saipan to Japan, and on many other long over-water trips. A total of 1,667 P-47N Thunderbolts was produced by the Farmingdale plant between December 1944 and December 1945, and a further 149 were delivered by the Evansville factory, bringing Thunderbolt production to a total of 15,660 machines. Some idea of the extent of Thunderbolt operations in the Pacific during the first five months of 1945 may be gauged from the fact that aircraft of this type flew an average of 1,677 sorties and dropped 541 tons of bombs per

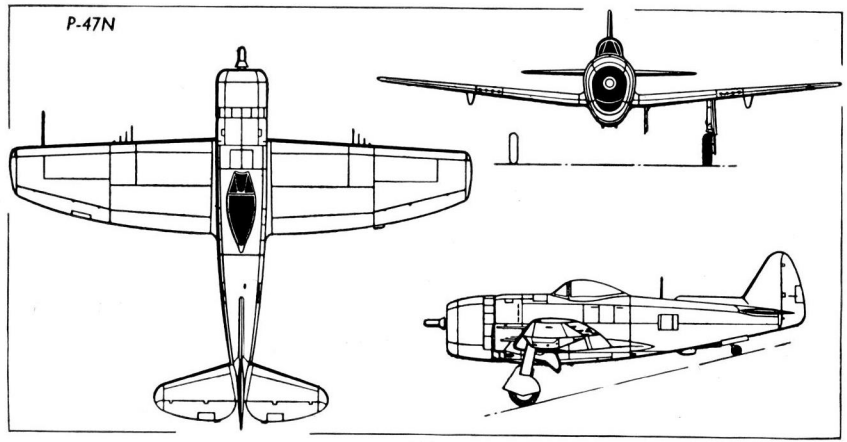
The P-47N-5-RE introduced zero-length rocket launchers.



day. From D-Day to V-E Day in Europe, Thunderbolts claimed the destruction of 86,000 railway wagons, 9,000 locomotives, 6,000 armoured vehicles and tanks, and 68,000 motor trucks, and by the end of the war Thunderbolt pilots had claimed the destruction of 3,752 enemy aircraft in the air and a further 3,315 on the ground. Two-thirds of all Thunderbolts produced eventually found their way to U.S.A.A.F. units in combat theatres, and losses of aircraft on operational missions were only 0.7 per cent of those despatched.

The following specification relates to the P-47M-1-RE, figures in parentheses relating to the P-47N-5-RE.

Type: *Single-seat Interceptor (Long-range Escort) Fighter (and Fighter-bomber).* **Power Plant:** *One* 2,800 *h.p. Pratt and Whitney R-2800-57(C) eighteen-cylinder radial air-cooled engine.* **Armament:** *Six or eight* 0.5-*in. Browning machine guns with* 267 *or* 425 (500) *r.p.g. (and two* 1,000-*lb. or three* 500-*lb. bombs or ten* 5-*in. rockets).* **Performance:** *Maximum speed,* 400 (397) *m.p.h. at* 10,000 *ft.,* 453 (448) *m.p.h. at* 25,000 *ft.,* 470 (460) *m.p.h. at* 30,000 *ft.; maximum climb rate,* 3,500 (2,770) *ft./min. at* 5,000 *ft.,* 2,650 (2,550) *ft./min. at* 20,000 *ft.; range (clean),* 560 (800) *mls. at* 10,000 *ft.* **Weights:** *Empty,* 10,423 (11,000) *lb.; normal loaded,* 13,275 (16,300) *lb.; maximum,* 15,500 (20,700) *lb.* **Dimensions:** *Span,* 40 *ft.* 9¾ *in.* (42 *ft.* 7 *in.); length,* 36 *ft.* 4 *in.; height,* 14 *ft.* 7 *in.; wing area,* 322 *sq. ft.*

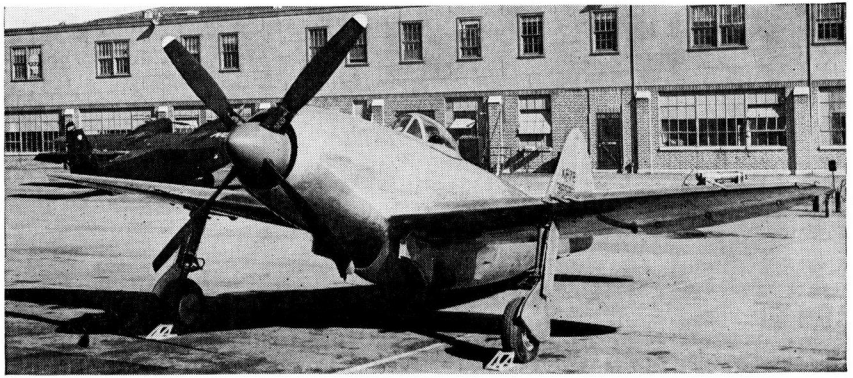


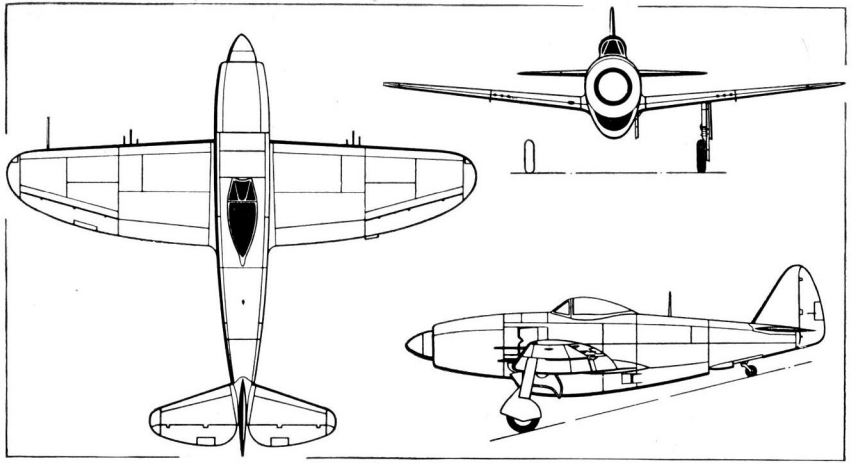
REPUBLIC XP-72 U.S.A.

Within two months of the first flight of the XP-47B Thunderbolt, Alexander Kartveli's design team had initiated design work on two further fighter designs which were eventually to be designated XP-69 and XP-72, the former being designed around the 2,500 h.p. Wright R-2160-3 engine and the latter utilising the 3,450 h.p. Pratt and Whitney R-4360-13 Wasp Major. The Wright R-2160-3 was an experimental forty-two-cylinder radial which was mounted aft of the pilot's cockpit driving contraprops via an extension shaft, and the XP-69, a prototype contract for which was placed in March 1943, was intended for high-altitude operation and featured a pressurized cockpit and an armament of two 37-mm. cannon and four 0.5-in. guns. Development of the XP-72 proceeded in parallel, this fighter being essentially a progressive development of the Thunderbolt, using a basically similar wing, and the greater promise displayed by this design resulted, on May 11, 1943, in the cancellation of the XP-69 in favour of the XP-72, two prototypes of which were ordered on June 18, 1943.

Incorporating many features of the Thunderbolt, the XP-72 was the first fighter to be designed around the twenty-eight-cylinder Wasp Major, the turbo-supercharger for which was placed aft of the cockpit, being geared to an extension shaft extending backward from the engine which was close-cowled and fan-cooled. The first XP-72, which was completed on January 29, 1944 and flown for the first time on February 2nd, had a four-blade airscrew, but the second XP-72, completed on June 26, 1944, had Aero Products contra-rotating airscrews. Both prototypes

The first prototype XP-72 which flew for the first time on February 2, 1944.





were powered by the R-4360-13 and carried six 0.5-in. wing-mounted guns with 1,600 rounds, and underwing shackles were provided for two 1,000-lb. bombs. Compressibility recovery flaps were fitted, and the XP-72 displayed an exceptional performance. One hundred production P-72 fighters were ordered, these having the R-4360-19 engine and an alternative built-in armament of four 37-mm. cannon, but the changing requirements of war demanded long-range escort fighters rather than interceptors, and the order for P-72s was cancelled, further development being abandoned in view of the greater promise offered by new turbojet-driven interceptors such as the Lockheed P-80 Shooting Star.

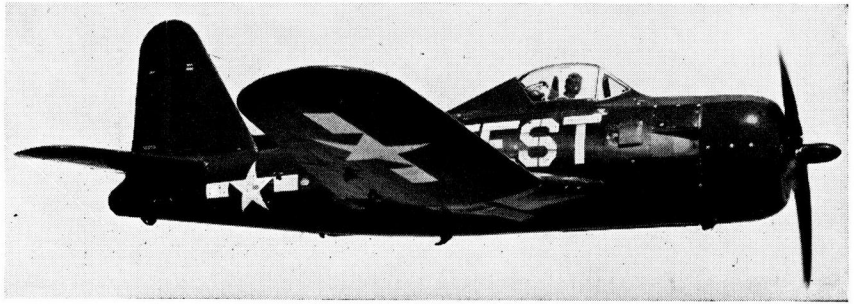
Type: *Single-seat Interceptor Fighter and Fighter-bomber.* **Power Plant:** *One* 3,450 *h.p. Pratt and Whitney R*-4360-13 *Wasp Major twenty-eight-cylinder radial air-cooled engine.* **Armament:** *Six* 0.5-*in. Browning machine guns with* 267 *r.p.g. plus two* 1,000-*lb. bombs.* **Performance:** *Maximum speed,* 490 *m.p.h. at* 25,000 *ft.; normal range,* 1,200 *mls. at* 300 *m.p.h.; maximum range (with two* 125 *Imp. gal. drop tanks),* 1,530 *mls. at* 315 *m.p.h.; initial climb rate,* 5,280 *ft./min.; climb rate at* 25,000 *ft.,* 3,550 *ft./min.; time to* 15,000 *ft.,* 3.5 *min., to* 20,000 *ft.,* 5 *min.; service ceiling,* 42,000 *ft.* **Weights:** *Empty,* 11,476 *lb.; normal loaded,* 14,433 *lb.; maximum,* 17,490 *lb.* **Dimensions:** *Span,* 40 *ft.* 11 *in.; length,* 36 *ft.* 7 *in.; height,* 16 *ft.* 0 *in.; wing area,* 300 *sq. ft.*

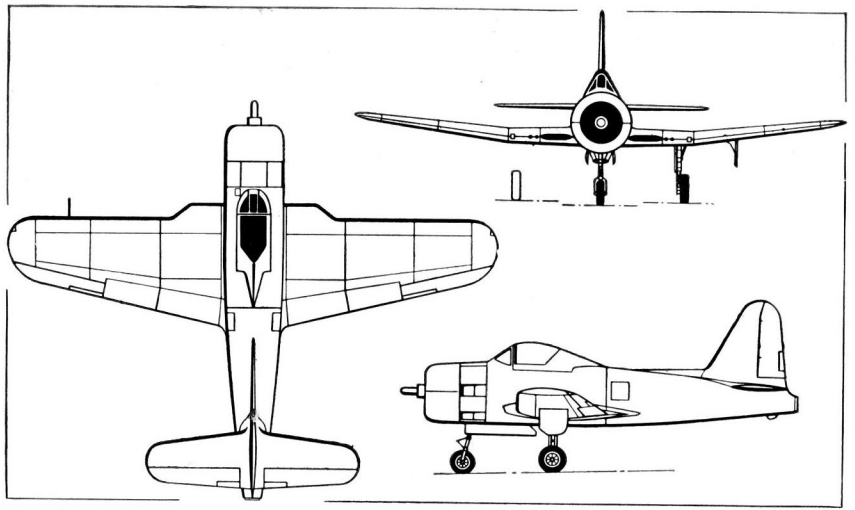
RYAN FR-1 FIREBALL — U.S.A.

The first fighter to combine a piston engine and a turbojet in a production airframe, the Ryan Model 28 Fireball represented one of the earlier attempts to overcome the problems of high landing speeds and severely restricted endurance suffered by pure jet fighters. First proposed in December 1942, the Fireball employed a conventional piston engine for cruising and an auxiliary turbojet to provide additional power for climb and maximum speed. Three prototypes were ordered under the designation XFR-1 on December 2, 1943, and, simultaneously, 100 production FR-1s were contracted for, the programme being handled on a crash basis to equip escort carrier squadrons. The first XFR-1 was flown on June 25, 1944 with a nine-cylinder Wright R-1820-56 Cyclone piston engine driving a Curtiss Electric airscrew in the nose and a General Electric I-16 (later re-designated J31) centrifugal single-stage turbo-jet in the rear fuselage and fed via wing-root intakes.

Production deliveries of the FR-1 began in March 1945, this model having an R-1820-72W Cyclone rated at 1,350 h.p. for take-off and 1,000 h.p. at 14,800 ft., and a J31-GE-3 turbojet affording 1,600 lb.s.t. It was one of the first U.S. Navy production aircraft to feature a completely flush-riveted exterior, and the laminar-flow, low-drag wings were power-folded for shipboard stowage. Armament comprised four 0.5-in. Browning MG 53-2 machine guns with 300 r.p.g. mounted outboard of the air intakes, and 189 lb. of armour was fitted. However, numerous teething troubles were encountered, delaying assignment to combat units. A further order calling for 1,000 FR-1s had been placed in January 1945, and following carrier trials, U.S. Navy squadron VF-66 began to work up with the new fighter. However, the war terminated before the unit became

An early FR-1 Fireball employed for test purposes in the summer of 1945. U.S. Navy squadron VF-66 was working up with the Fireball when the war ended.





operational, and V-J Day resulted in the cancellation of 1,044 FR-1s, the remaining sixty-six being delivered by November 1945. Several of these were later modified for test purposes, one machine having an R-1820-74W Cyclone as the XFR-2, another having a 2,000 lb.s.t. General Electric I-20 turbojet and a -74W Cyclone, and the XFR-4 having a similar piston engine and a 4,200 lb.s.t. Westinghouse J34 turbojet fed via flush fuselage intakes.

Type: *Single-seat Shipboard Fighter-bomber.* **Power Plants:** *One* 1,425 *h.p. Wright R-1820-72W Cyclone nine-cylinder radial air-cooled engine and one* 1,600 *lb.s.t. General Electric J31-GE-3 centrifugal turbojet.* **Armament:** *Four* 0.5-*in. Browning MG* 53-2 *machine guns with* 300 *r.p.g. plus one* 1,000-*lb. bomb or eight* 5-*in. rockets.* **Performance:** *Maximum speed (both power plants),* 426 *m.p.h. at* 18,100 *ft., (Cyclone only),* 399 *m.p.h. at sea level, (Cyclone only),* 295 *m.p.h. at* 16,500 *ft.; economical cruising speed,* 153 *m.p.h.; range (internal fuel),* 1,030 *mls. at* 153 *m.p.h., (with one* 125 *Imp. gal. drop tank),* 1,430 *mls. at* 149 *m.p.h.; initial climb rate,* 4,800 *ft./min.; time to* 10,000 *ft.,* 2.4 *min., to* 20,000 *ft.,* 5.6 *min.; service ceiling,* 43,100 *ft.* **Weights:** *Empty,* 7,915 *lb.; normal loaded,* 9,862 *lb.; maximum,* 10,595 *lb.* **Dimensions:** *Span,* 40 *ft.* 0 *in.; length,* 32 *ft.* 4 *in.; height,* 13 *ft.* 7¼ *in., wing area,* 275 *sq. ft.*

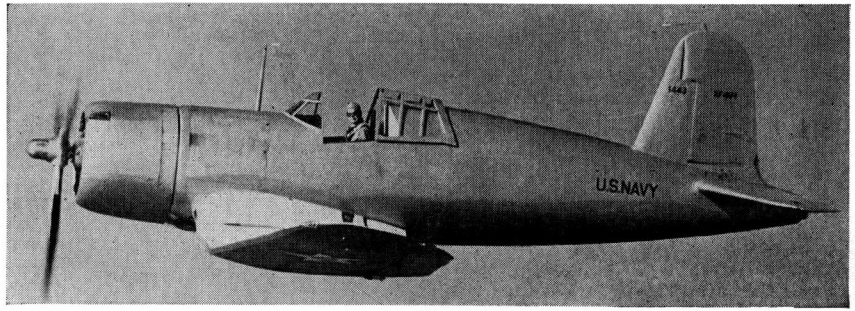
VOUGHT F4U-1–F4U-4 (FG-1–CORSAIR) U.S.A.

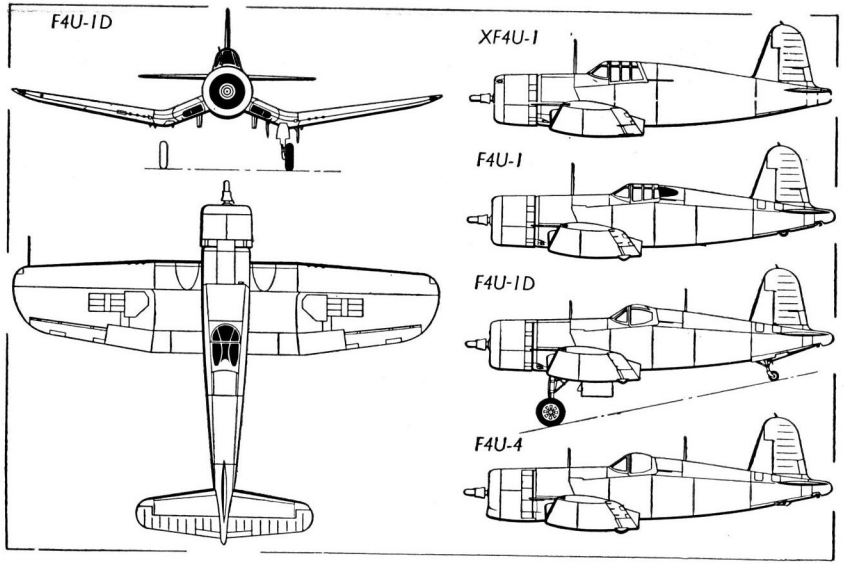
Universally acknowledged to be the finest shipboard fighter of World War II, the Corsair was superior in most performance respects to the redoubtable P-51 Mustang land-based fighter below 20,000 ft., yet it spent more than half its wartime operational career confined to land bases, not operating from U.S. carrier decks until the end of 1944. The Corsair was evolved to participate in a U.S. Navy design contest for a single-seat shipboard fighter, details of which were issued to manufacturers on February 1, 1938, and a prototype was ordered from Chance Vought Aircraft as the XF4U-1 on June 30, 1938.

Designed around the new XR-2800 Double Wasp engine by Rex B. Beisel and his team, the XF4U-1 featured an inverted gull wing configuration, selected in order to provide the necessary ground clearance for the enormous Hamilton Standard airscrew while keeping undercarriage length and ground angle to a minimum, and simultaneously obtain the optimum right angle for minimum drag at the junction of the wing and fuselage. The XR-2800-4 engine provided 1,850 h.p. for take-off and 1,460 h.p. at 21,500 ft., and armament comprised a 0.3-in. and a 0.5-in. machine gun in the forward fuselage decking, a single 0.5-in. gun in each wing and a receptacle in each wing for ten light bombs which were to be dropped on bomber formations.

The XF4U-1 was flown for the first time on May 29, 1940 by Lyman A. Bullard, Jnr., and the prototype's sensational performance was immediately apparent. On October 1, 1940, the XF4U-1 was flown from Stratford to Hartford, during the course of which it attained 404 m.p.h., thus becoming the first U.S. fighter of any type to exceed 400 m.p.h. Weighing 7,505 lb. empty and 9,357 lb. in normal loaded condition, the XF4U-1 had an initial climb rate of 2,660 ft./min. and a service ceiling of 35,200 ft., and such was the length of the test programme conducted with

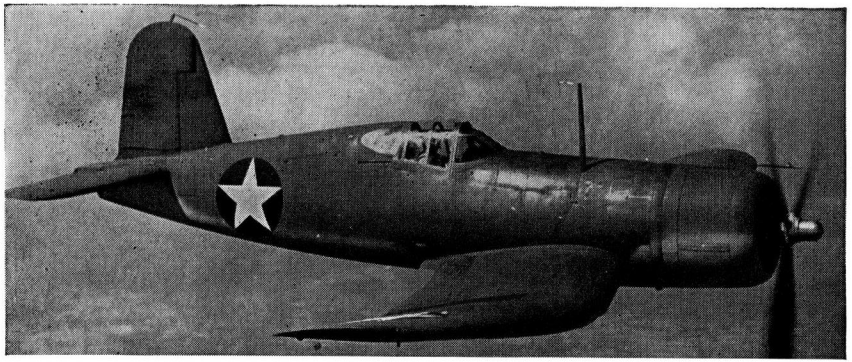
The XF4U-1 Corsair prototype which became the first U.S. fighter of any type to exceed 400 m.p.h.

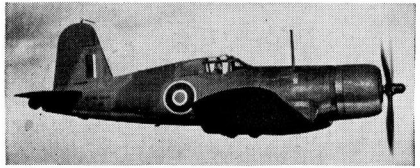




this prototype that it was destined not to be delivered to the U.S. Navy until December 1942, some time after the 100th production aircraft had been accepted!

Despite the superlative performance demonstrated by the prototype, European combat reports revealed the need for major modifications in order to improve the fighter's operational capability. The need for a heavier armament was readily apparent and, therefore, it was decided to remove the fuselage-mounted guns and place two additional 0.5-in. guns with greatly increased ammunition capacity in each outer wing panel. To make room for this wing armament, the integral fuel tanks in the centre section and outer panel leading edges had to be removed, and to compensate for this loss of fuel capacity, a single 197 Imp. gal. self-sealing tank had to be housed in the fuselage. To avoid trim changes as fuel was consumed, this tank had to be positioned as near as possible to the fighter's c.g., and this necessitated moving the cockpit a full three feet aft to provide the space. The repositioning of the cockpit resulted in a greatly inferior view forward for the pilot, and one of the primary





An early production F4U-1 Corsair and (left) a Corsair I with interim canopy.

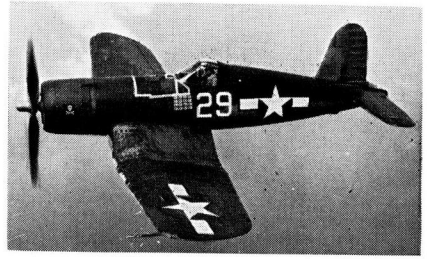
reasons for the fighter's initial unsuitability for shipboard use.

A letter of intent for the production contract was issued by the U.S. Navy on March 3, 1941, following final acceptance demonstrations of the prototype at Anacostia in February, and an initial contract for 584 F4U-1s was placed on June 30, 1941, the fighter being named Corsair like the earlier Vought naval observation aircraft. The first production F4U-1 was flown on June 25, 1942, early machines having the interim armament of four wing-mounted 0.5-in. Browning guns, although this was increased to six at an early stage. Armour plate weighing 155 lb. was added around the cockpit and oil tanks, together with a bullet-proof windscreen, IFF equipment was installed, and aileron span was increased to achieve a higher rate of roll. To compensate for the inevitable increase in gross weight, a 2,000 h.p. R-2800-8 engine was installed, the fuselage length had been increased from 31 ft. 11 in. to 33 ft. 4 in., and rearward view was increased by the addition of transparent panels behind the cutaway head-rest.

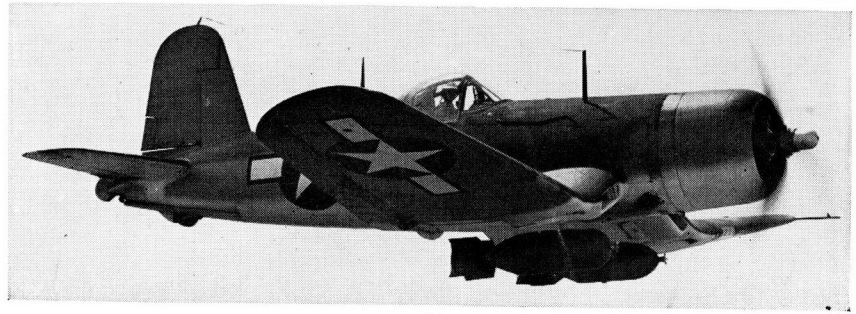
The U.S. Navy received its first F4U-1 on July 31, 1942, and by September enough Corsairs had been delivered to equip the U.S. Marine Corps squadron VMF-124 which was formed on September 7, 1942 from the remnants of VMF-122. The first U.S. Navy squadron to be equipped with the Corsair, VF-12, followed shortly afterwards for embarkation on the U.S.S. *Saratoga*. VMF-124 was declared combat-ready on December 28,

1942, by which time 178 Corsairs had been produced, and twelve of this squadron's aircraft arrived at Guadalcanal on February 12, 1943, flying the Corsair's first combat mission of World War II on the following day. In the meantime, the U.S. Navy's VF-12 had been pronounced combat-ready on January 14th, but carrier trials, initiated aboard the U.S.S. *Sangamon* in September 1942, had proved disappointing. Forward visibility was considered inadequate for deck operations, the Corsair tended to swing badly on touch-down and, owing to the stiff landing gear, it was prone to bouncing, and although VF-12 became "deck-qualified" in April 1943, the U.S. Navy considered the Corsair to be unsuitable for carrier use. Thus, its first operational F4U-1 squadron, VF-17, formed in April 1943, was land-based on reaching the New Georgia area in September.

VF-17 was actually the first unit to receive the modified F4U-1A which featured a frameless clear-view-type canopy, the cockpit being raised by seven inches to improve forward vision. Directional stability for landing was improved by increasing the height of the tailwheel leg, changing its tyre from a solid to a pneumatic type, and adding a small spoiler on the starboard wing leading-edge. These changes were introduced on the 689th production Corsair which became the first F4U-1A. The 1,550th production machine, the 862nd F4U-1A Corsair, introduced the R-2800-8W engine with water injection, and 1,958 Corsairs had been delivered by Chance



(*Right*) *An F4U-1A and* (*below*) *an F4U-1D.*



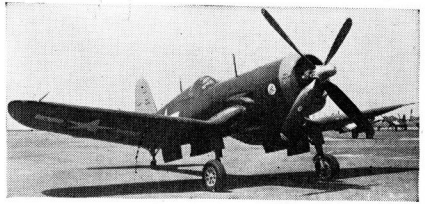
Vought by the end of 1943. To these were added 377 Goodyear-built machines and 136 built by Brewster. These two companies had joined the Corsair production programme in 1942, Goodyear beginning delivery of the fixed-wing FG-1 (approximating to the F4U-1 apart from lack of wing folding) on February 25, 1943, and the first Brewster-built Corsair, designated F3A-1, followed into the air on April 26, 1943.

Under Lend-Lease arrangements, Britain's Fleet Air Arm took delivery of ninety-five F4U-1s as Corsair Is and 510 F4U-1As as Corsair IIs. Initial deliveries of the Corsair I to the F.A.A. began on June 1, 1943, when No. 1830 Squadron formed at Quonset, and before the end of the year seven more F.A.A. squadrons were working up on Corsair Is and IIs. These underwent several modifications in British service, and some 16-in. was clipped from their wingtips to permit below-deck stowage on the smaller British carriers. The Corsair Is were also fitted with bulged front hoods to improve the forward view by permitting the pilot to raise his seat. Rocket rails were fitted to the wings, and the early machines were rapidly given provision for a ventral drop tank beneath the fuselage as a prelude to more offensive stores. The first operational sorties were undertaken by the Corsair IIs of No. 1834 Squadron from H.M.S. *Victorious* on April 3, 1944 when these aircraft provided fighter cover for torpedo-bombers attacking the German battleship *Tirpitz*. Chance Vought-built Lend-Lease Corsairs for the F.A.A. were designated F4U-1Bs by their manufacturer, but Britain was also supplied with other Corsairs by the supplementary production companies. Four hundred and thirty Brewster-built F3A-1Ds were supplied as Corsair IIIs and 977 Goodyear-built FG-1Ds were received as Corsair IVs, Britain thus receiving 2,012 Corsairs which equipped nineteen squadrons. A further 370 F4U-1Ds were delivered to the R.N.Z.A.F. which operated three squadrons equipped with this type.

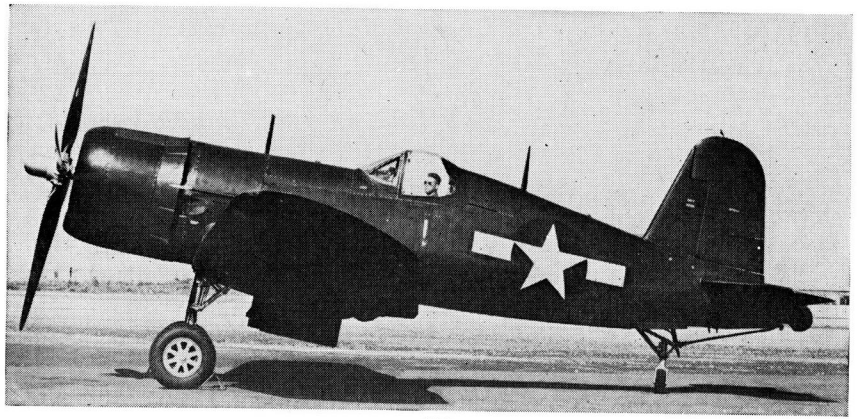
On August 30, 1943, a modified version of the Corsair, the F4U-1C, was delivered, this having four 20-mm. wing-mounted M2 cannon in place of the sextette of 0.5-in. weapons. Two hundred F4U-1Cs were delivered, these aircraft proving particularly potent for ground strafing, but most American pilots preferred the original armament, and the next version, the F4U-1D, reverted to the six 0.5-in. guns with 400 r.p.g., augmented, however, by twin pylons beneath the centre section for fuel tanks or a pair of 1,000-lb. bombs. The F4U-1D did not enter production until April 1944, being produced by Brewster as the F3A-1D and by Goodyear as the FG-1D. Vought built a total of 4,102 F4U-1s, Brewster had completed 735 F3A-1s when the company's badly-managed production line was terminated in July 1944, and Goodyear manufactured 3,808 FG-1s.

By the spring of 1944 the U.S. Navy was still refusing to accept the Corsair for shipboard operations, but after highly successful trials performed by VF-301 aboard the U.S.S. *Gambier Bay* in April 1944, the fighter was finally cleared for use aboard U.S. Navy carriers—some nine months after the F.A.A. had commenced shipboard operations with the type!

In the meantime, a number of developments of the basic Corsair design had been in progress. As early as June 14, 1941, the U.S. Navy had requested a design study for a high-altitude model equipped with a new two-stage supercharger, and three prototypes were ordered in March 1942 as the XF4U-3. These aircraft were to be fitted with the XR-2800-16(C) engine which, with a 1009A turbo-supercharger, maintained its 2,000 h.p. up to 40,000 ft. A four-bladed Hamilton Hydromatic airscrew was fitted and the supercharger intake took the form of a large scoop beneath the engine cowling. The three Vought-built XF4U-3s were to be followed by twenty-seven similar Goodyear-built FG-3s, but in the event the first XF4U-3 was not completed until 1946, and the number of FG-3s was reduced to thirteen for very high altitude test work. In December 1941, just before the attack on Pearl Harbour, Chance Vought were requested to design a night fighting version of the Corsair which was submitted on January 6, 1942 as the XF4U-2. Pressure of work prevented further development of the project by Chance Vought, however, and instead the necessary modifications were incorporated in twelve standard F4U-1s by the Naval Aircraft Factory at Philadelphia which deleted two guns and installed an early mark of A.I. radar with a radome on the starboard wingtip and an autopilot. Designated F4U-2s, these aircraft were given brief trials and six were provided a specialist night fighter unit, VFN-75, at Munda, New Georgia, where one of these gained



(Above, right) The F4U-4XB and (below) the F4U-4XA which served as prototypes for the F4U-4.



the distinction of effecting the first night interception by a single-seat radar-carrying fighter. The other six F4U-2s went to VFN-101 on board the U.S.S. *Essex*, these later operating also from the *Hornet* and the *Intrepid*.

The final wartime production model of the Corsair was the F4U-4 projected in mid-1943. The first prototype, a modified F4U-1 redesignated F4U-4XA, was flown on April 19, 1944, being followed by a second prototype, the F4U-4XB, on July 12th, and the first production F4U-4 flew on September 20th. The principal changes included the installation of the R-2800-18W or -42W engine driving a 13 ft. 2 in.-diameter airscrew and using water injection which boosted the normal maximum rating of 2,100 h.p. to 2,450 h.p. and raised maximum speed from 425 m.p.h. to 446 m.p.h. The cockpit was redesigned and featured a revised canopy and a new armour-plated bucket seat and regrouped instruments. The standard six 0.5-in. gun armament was retained but a total of 197 lb. of armour was fitted. A change was made to a downdraught carburettor, the intake ducts for which were moved from the wing leading-edges to beneath the engine cowling, and improved access to radio equipment was made possible by a folding seat back.

The U.S. Navy accepted its first F4U-4 Corsair on October 31, 1944, and five hundred had been delivered by the following April. The F4U-4B had been allocated to the British Fleet Air Arm, but none were actually received by that service, and other versions included the F4U-4C, some 300 of which were delivered with four 20-mm. cannon armament, the F4U-4E with APS-4 radar, the F4U-4N with APS-6 radar, and the F4U-4P tactical reconnaissance model with cameras in the fuselage. Goodyear produced two hundred similar aircraft under the designation FG-4. A total of 1,912 F4U-4 Corsairs had been built by V-J Day, but relatively few reached operational service, although those that did gave an extremely good account of themselves.

Little-known research ventures by Goodyear included two FG-1As with cut-down rear fuselages and all-round-vision bubble-type cockpit canopies, these changes being proposed for production aeroplanes at one time. One FG-1 had a Westinghouse Model 19A turbojet mounted beneath the fuselage for flight trials. This was one of the first U.S. turbojets and was airborne for the first time beneath the FG-1. Production of the Corsair continued after the termination of hostilities, postwar models including the F4U-5, F4U-7 and AU-1. By V-J Day, U.S. Corsairs in the Pacific theatre had destroyed 2,140 enemy aircraft in aerial combat for the loss of 189. Operational sorties from February 13, 1942 totalled 64,051, 54,470 being made from land bases and 9,581 from carriers.

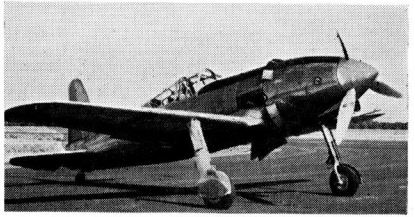
The following specification relates to the F4U-1D Corsair, figures in parentheses relating to the F4U-4.

Type: *Single-seat Shipboard Interceptor and Fighter-bomber.* **Power Plant:** *One* 2,250 (2,450) *h.p. Pratt and Whitney R-2800-8W (-18W) Double Wasp eighteen-cylinder radial air-cooled engine.* **Armament:** *Six* 0.5-*in. Browning MG* 53-2 *machine guns with* 400 *r.p.g. plus two* 1,000-*lb. bombs or eight* 5-*in. rockets.* **Performance:** *Maximum speed,* 328 (381) *m.p.h. at sea level,* 425 (446) *m.p.h. at* 20,000 (26,200) *ft.; initial climb rate,* 3,120 (3,870) *ft./min.; service ceiling,* 37,000 (41,500) *ft.; normal range,* 1,015 (1,005) *mls.; maximum range,* 1,562 (1,560) *mls.* **Weights:** *Empty,* 8,694 (9,205) *lb.; normal loaded,* 12,039 (12,420) *lb.; maximum,* 13,120 (14,670) *lb.* **Dimensions:** *Span,* 40 *ft.* 11 *in.; length,* 33 *ft.* 4 *in.* (33 *ft.* 8 *in.); height,* 15 *ft.* 1 *in.* (14 *ft.* 9 *in.); wing area,* 314 *sq. ft.*

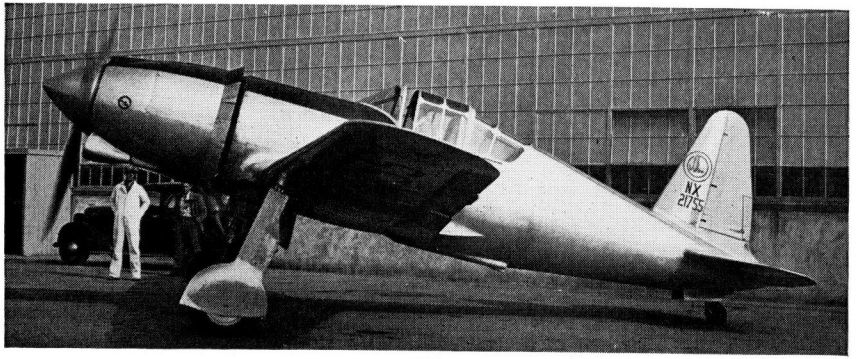
VULTEE (P-66) VANGUARD — U.S.A.

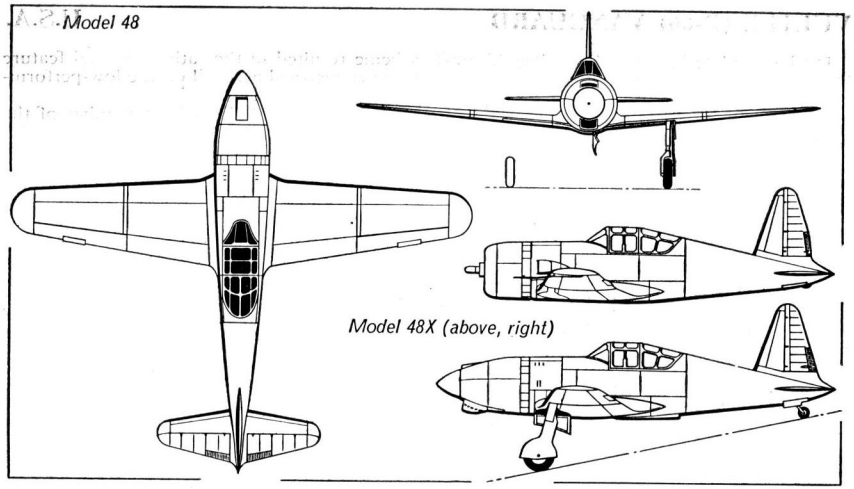
During the late 'thirties, the Vultee Aircraft Division of the Aviation Manufacturing Corporation conceived the original idea of evolving four types of aircraft for different military roles, all using the same basic tooling and featuring common wings, aft fuselage and tail assembly. The four types received the company designations P-48, BC-51, B-54 and B-54D. The P-48 was a single-seat fighter; the BC-51 was a basic combat trainer (eventually becoming the BC-3); the B-54 was an advanced trainer, and the B-54D (eventually developed as the BT-13) was a basic trainer. The P-48, BC-51 and B-54 had the same centre section and retractable undercarriage, and the BC-51, B-54 and B-54D had the same wing outer panels which had a greater span but the same wingtip and root chord as those of the P-48. Since all wings were built in the same jigs, this scheme resulted in the rather unusual feature of a symmetrical aerofoil on the low-performance basic trainer!

Detail design of the fighter member of the quartette began in 1938. The P-48 featured a steel-tube, metal-covered semi-monocoque fuselage, a two-spar wing, a fully retractable



The original Model 48 *with extended drive shaft and close-cowled radial air-cooled engine.*

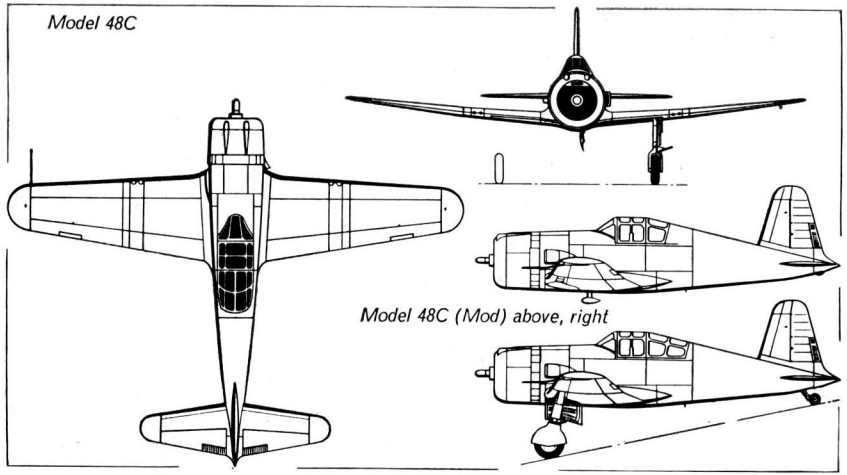




undercarriage, and hydraulically-actuated split flaps and, as originally conceived, was powered by a Pratt and Whitney R-1830-S4C4-G air-cooled radial rated at 1,200 h.p. for take-off and 900 h.p. at 15,400 ft., this being enclosed by an orthodox cowling. While the first prototype was under construction, however, it was decided to adopt a lengthened drive-shaft and a long, pointed cowling to reduce drag, cooling being effected by means of a variable air intake immediately aft of the airscrew spinner, beneath the nose. In this form, the Model P-48 (NX21755) was completed and flown for the first time in September 1939, and the name Vanguard adopted.

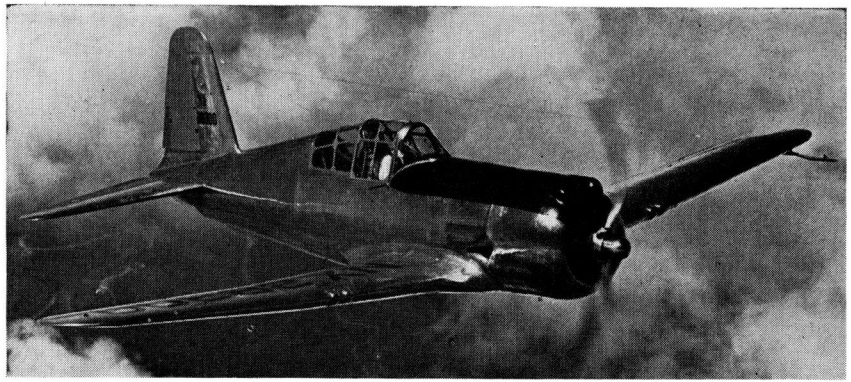
From the outset of flight testing inadequate engine cooling was experienced and, after a few flights, the variable air inlet beneath the nose was fixed in the "open" position, and a further scoop was added above the cowling. Simultaneously rudder area was increased. At this time, the proposed production version was designated Model 61, but only limited flight testing had been completed when, on May 9, 1940, the prototype collided with a Lockheed Sirius while landing at Vultee Field, the impact severing one main undercarriage leg. Nevertheless, the pilot, Vance Breese, skilfully landed the Vanguard with little additional damage.

By this time it had already been concluded that the close-fitting cowling and extension

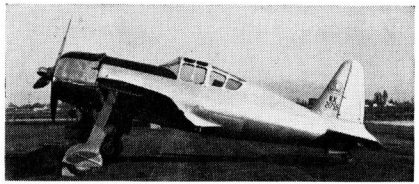


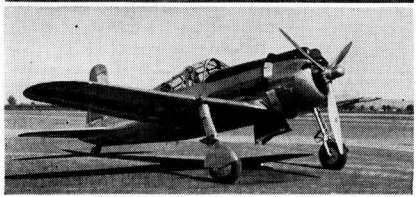
shaft arrangement was not entirely satisfactory. It was heavy and the negligible drag reduction that it offered was insufficient to compensate for the cooling and carburettor ducting problems. Thus, the second prototype, the Model 48X (NX19999) which had flown on February 11, 1940, had reverted to the orthodox radial cowling that had originally been envisaged for the design. The first prototype was rebuilt with an orthodox radial cowling, and the second machine differed from this aeroplane in having compound wing dihedral, modified main undercarriage members, a rearward-retracting tailwheel, and provision for twin guns in the forward fuselage and two wing guns. Some instability experienced at an early flight test stage resulted in substantial increases in the areas of both the vertical and horizontal tail surfaces. The Model 48X with the R-1830-S4C4-G engine attained a maximum speed of 358 m.p.h. at 15,600 ft., and had a maximum cruising speed of 316 m.p.h. An altitude of 3,300 ft. was attained in one minute, service ceiling was 34,300 ft., and normal range was 738 mls.

On February 6, 1940, Vultee had received an order from the Swedish government for 144 Vanguards, and applied the designation Model 48C to the production version, a production prototype (NX28300) flying for the first time on September 6, 1940. This was essentially similar to the Model 48X but had an R-1830-S3C4-G engine with the same take-off rating but offering 1,050 h.p. at 13,100 ft., and pro-

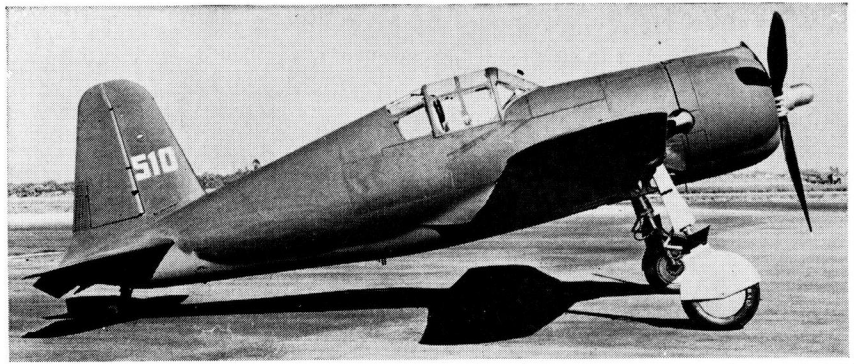


(*Above*) *The Vanguard production prototype.* (*Below, left*) *The modified first prototype and* (*bottom*) *the second prototype.*



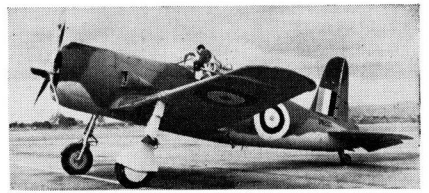


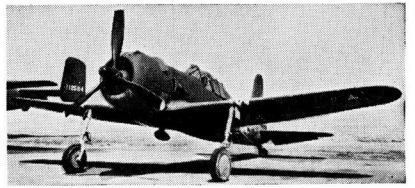
vision for four 0.3-in. wing-mounted guns in addition to two 0.5-in. guns in the fuselage. Production deliveries of the Model 48C Vanguard began in September 1941, but the U.S. government had placed an embargo on the export of warplanes to Sweden, and the British government therefore took over the Swedish contract, envisaging the use of the Vanguard as an advanced trainer in Canada. British serial numbers were allocated to the aircraft, and at least the first two production Vanguards were completed in R.A.F. finish with the serial numbers BW208 and BW209, but none were, in fact, accepted by the R.A.F., the British government relinquishing the fighters in favour of China. One hundred and twenty-nine of the 144 Vanguards manufactured were supplied to the Chinese government under the Lend-Lease programme, the remaining machines, which had received the U.S.A.A.F.



(*Above*) *A late production Model* 48*C.* (*Below, right*) *The second production machine in R.A.F. finish and* (*bottom*) *a P-66.*

designation P-66, being assigned to pursuit training bases on the American West Coast. Deliveries were completed in April 1942, late production P-66s having a reduced transparent area aft of the pilot's seat.





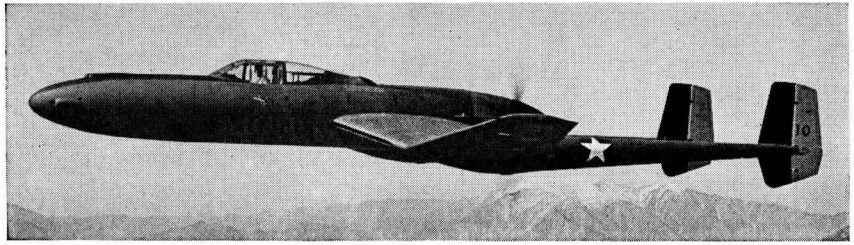
Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 1,200 *h.p. Pratt and Whitney R-*1830-33 *fourteen-cylinder radial air-cooled engine.* **Armament:** *Four* 0.3-*in. and two* 0.5-*in. machine guns.* **Performance:** *Maximum speed,* 340 *m.p.h. at* 15,100 *ft.; maximum cruising speed,* 331 *m.p.h. at* 14,500 *ft.; range* (154 *Imp. gal.*), 850 *mls. at* 290 *m.p.h. at* 17,000 *ft.,* 950 *mls. at* 240 *m.p.h. at* 10,000 *ft.; time to* 2,520 *ft.,* 1 *min., to* 19,700 *ft.,* 9.2 *min.; service ceiling,* 28,200 *ft.* **Weights:** *Empty,* 5,235 *lb.; loaded,* 7,100 *lb.; maximum,* 7,384 *lb.* **Dimensions:** *Span,* 36 *ft.* 0 *in.; length,* 28 *ft.* 5 *in.; height,* 9 *ft.* 5 *in.; wing area,* 197 *sq. ft.*

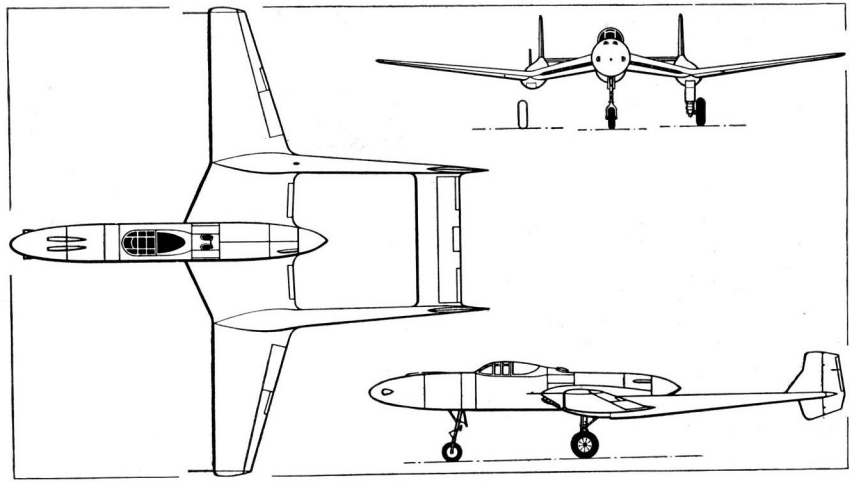
VULTEE XP-54 U.S.A.

The XP-54 was designed to meet the same Circular Proposal R-40C which resulted in the Curtiss XP-55 and the Northrop XP-56, Vultee Aircraft's design actually winning the competition. Designated Model 84 by the manufacturers, the fighter was actually an outgrowth of an earlier Vultee proposal, the Model 78, which, of basically similar configuration, was to have been powered by an unsupercharged Allison V-1710 engine. The initial contract covering preliminary engineering data and wind tunnel models of the proposed fighter was approved on June 22, 1940, and on January 8, 1941, a contract for one prototype designated XP-54 was approved, a second XP-54 being ordered on March 17, 1942.

The engine originally planned for installation in the XP-54 was the Pratt and Whitney X-1800, a similar power plant having been specified for the two competitive designs, but the discontinuation of this engine led to its substitution by the liquid-cooled Lycoming XH-2470, production models of which were expected to have a 2,200 h.p. rating. The development of a pressurized cockpit for the XP-54 had been initiated on September 7, 1940, when the original low-level mission envisaged for the fighter was changed to that of high-altitude interceptor. This also necessitated the installation of turbo-supercharging equipment which, together with the introduction of heavy armour protection, resulted in the originally

(Above, left and below) The first XP-54 (41-1210) which flew on January 15, 1943. The XP-54 was the winner of a contest calling for a fighter of unorthodox configuration.





estimated gross weight of 11,500 lb. creeping up to 18,000 lb.

The XP-54 embodied several unique features. The centre wing was designed around the "ducted wing section" newly developed by the N.A.C.A., this enabling the oil and coolant radiators and the intercoolers to be housed completely within the wing. The landing flaps were so designed that their secondary function was to regulate the airflow through the coolers. Owing to the considerable height of the aircraft from the ground cockpit access presented a major design problem, and to overcome this one of the most interesting features of the aeroplane was evolved—a seat which functioned as an elevator. Electrically operated, the seat could be activated from outside the XP-54 to lower it into entrance position, and once seated the pilot could control the elevation from the seat and raise it into flight position. This ventral access was of value also in that it simplified the design of a pressure-tight cockpit canopy. The entire nose section was hinged on the nosewheel leg pivot shaft and could be moved through a range of three degrees up to six degrees down. Rigidly mounted in this nose section was a pair of 37-mm. T-9 cannon and twin 0.5-in. guns were attached to moveable mounts. The movement of the nose section and the machine guns was controlled by a special compensating gun sight, but due to the muzzle velocities of the

The second XP-54 (41-1211) made only one test flight before the programme was terminated.

cannon and machine guns being very different, these weapons had to assume different elevations to compensate for their trajectories. The idea was to permit the cannon to be elevated to fairly high angles from normal without affecting the flight attitude of the fighter.

The first XP-54 flew for the first time on January 15, 1943, but early trials indicated that performance was substantially below that guaranteed. At this time, it was also decided to terminate development of the Lycoming engine, and although it appeared possible to install the Allison 3420 in the XP-54 airframe without major structural changes, the delay and expense involved in making such a change resulted in no further consideration being given to the quantity production of the aircraft. The experimental programme was continued, however, and the first XP-54 had accumulated 63 hrs. 10 mins. in the air when it was finally delivered to the A.A.F. at Wright Field. The second XP-54 flew on May 24, 1944, flying to Norton A.F.B., Calif., where the complete nose section was removed and sent to Eglin A.F.B. for gun-firing trials. Difficulties with the Lycoming engines and shortage of spares resulted in the final termination of the test programme.

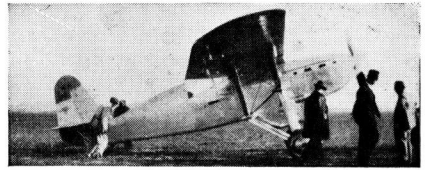
Type: *Single-seat High-altitude Interceptor.* **Power Plant:** *One* 2,300 *h.p. Lycoming XH-2470-1 liquid-cooled engine.* **Armament:** *Two* 37-*mm. T-12/T-13 cannon with* 60 *r.p.g. and two* 0.5-*in. M2 machine guns with* 500 *r.p.g.* **Performance:** *Maximum speed,* 381 *m.p.h. at* 28,500 *ft., 290 m.p.h. at sea level; initial climb rate,* 2,300 *ft./min.; service ceiling,* 37,000 *ft.; time to* 32,100 *ft.,* 27.7 *min.* **Weights:** *Empty,* 15,262 *lb.; normal loaded,* 18,233 *lb.; maximum,* 19,337 *lb.* **Dimensions:** *Span,* 53 *ft.* 10 *in.; length,* 54 *ft.* 8¾ *in.; height,* 14 *ft.* 6 *in.; wing area,* 455.5 *sq. ft.*

IKARUS IK-2

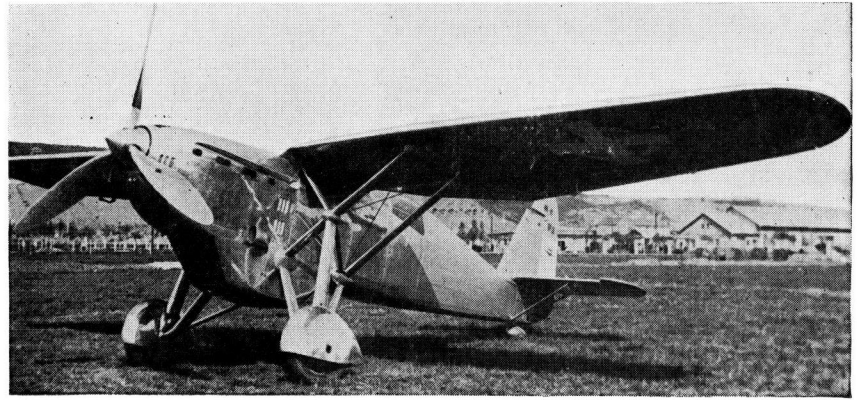
YUGOSLAVIA

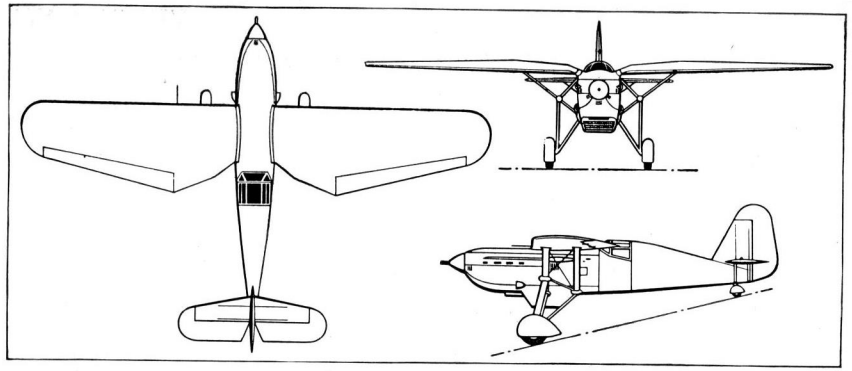
During the early 'thirties, Yugoslav fighter squadrons were largely equipped with the Avia B.H.33 biplane built under licence by the Ikarus A.D. In 1931 six Hawker Furies had been ordered from the U.K., and the Zmaj company produced Gourdou-Leseurre B.3 and Dewoitine D.27 fighters under French licence, but many young engineers believed that Yugoslavia, possessing a healthy aircraft industry, should be capable of producing successful fighters of indigenous design. Accordingly, Kosta Sivčev and Ljubomir Ilić began the design of a cannon-armed, all-metal high-wing fighter monoplane as a private venture. Designated IK-1, a prototype was ordered from the Ikarus A.D. in 1934, and was delivered for flight trials in April 1935.

Powered by an 860 h.p. Hispano-Suiza 12Ycrs engine, the IK-1 carried a 20-mm. HS-404 engine-mounted cannon and two 7.92-mm. Darne machine guns. Tests were conducted at Zemun airfield by Captain Leonid Bajdak who strongly favoured the biplane over the monoplane. During the second flight Bajdak put the IK-1 through a full range of aerobatics, but it failed to recover from a power dive during the third flight, and Bajdak, who



(*Below and right*) *The Ikarus IK-1 prototype.*





parachuted to safety, reported that the aircraft was totally unsuited for use as a fighter. A detailed examination of the wreckage revealed the fact that the fabric covering of the port wing had failed as a result of negligence in sewing the seams, and therefore it was decided to proceed with a second prototype.

The second aircraft, which was designated IK-2, was completed in June 1936, and featured metal skinned wings and a shallower radiator bath. A new test pilot, Dobnikar, undertook the preliminary flight trials of the IK-2, and the prototype was flown in mock combat with a Hawker Fury flown by Captain Bajdak, the IK-2 out-performing the biplane on all counts. The outcome of these trials prompted the High Command of the Yugoslav Air Force to order a production batch of twelve IK-2 fighters, and these were all delivered by Ikarus during 1937.

When German forces invaded Yugoslavia in April 1941, eight IK-2 fighters were still serving with the 34th Squadron of the 4th Fighter Regiment alongside six Hurricanes. The IK-2s were used primarily to strafe the advancing German columns, and those fighters that survived were absorbed by the Croatian Air Force. One development of the basic design was proposed by Ikarus, this being the two-seat IK-4 reconnaissance monoplane. However, the Yugoslav Air Force preferred the Henschel Hs 126, and the IK-4 was not ordered.

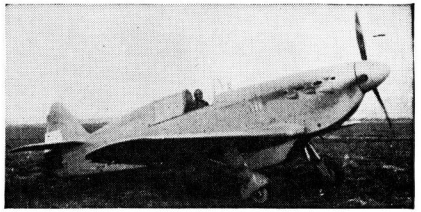
Type: *Single-seat Fighter.* **Power Plant:** *One* 860 *h.p. Hispano-Suiza* 12*Ycrs twelve-cylinder Vee liquid-cooled engine.* **Armament:** *One* 20*-mm. Hispano-Suiza HS-*404 *cannon with* 60 *rounds and two* 7.92*-mm. Darne machine guns.* **Performance:** *Maximum speed,* 266 *m.p.h. at* 16,400 *ft., 211 m.p.h. at sea level; range at economic cruising speed,* 248 *mls.; time to* 16,400 *ft.,* 5 *min.* 22 *sec.; absolute ceiling,* 34,450 *ft.* **Weights:** *Empty,* 3,175 *lb.; loaded,* 4,255 *lb.* **Dimensions:** *Span,* 37 *ft.* 4¾ *in.; length,* 25 *ft.* 10⅓ *in.; height,* 12 *ft.* 7⅛ *in.; wing area,* 193.75 *sq. ft.*

ROGOŽARSKI IK-3

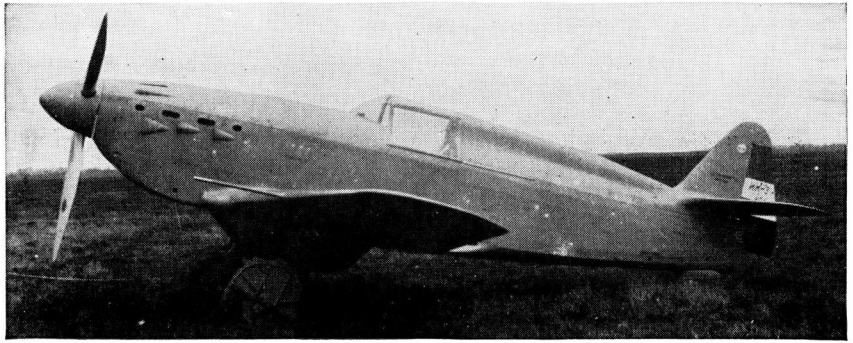
YUGOSLAVIA

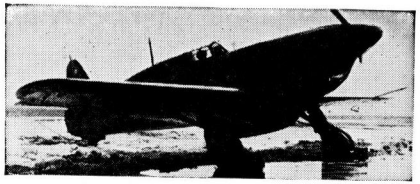
In 1936 it was becoming obvious that the heyday of the biplane and high-wing monoplane configurations for single-seat high-speed fighters was passing, and all the major aircraft-manufacturing nations were turning their attention to the low-wing monoplane with a fully-retractable undercarriage. Influenced by this trend, the designers of the IK-1 and IK-2, Ljubomir Ilić and Kosta Sivčev, were joined by Ing. Zrnić and initiated work on a new fighter project, the low-wing IK-3 of mixed construction and featuring a retractable undercarriage. All preparatory work was undertaken in strict secrecy, and a model was tested in the Eiffel wind tunnel in Paris before the design was submitted to the Yugoslav Air Ministry. The Rogožarski A.D. at Belgrade was instructed to proceed with the construction of a prototype which flew for the first time in the spring of 1938 with Captain M. Bjelanovic at the controls.

The prototype IK-3 was powered by a Hispano-Suiza 12Y-29 liquid-cooled engine rated at 890 h.p. for take-off and 920 h.p. at 11,810 ft., and carried an armament of one 20-mm. Hispano-Suiza HS-404 cannon between the cylinder banks and two 7.92-mm. FN-



(*Below and right*) *The prototype IK-3 fighter which was flown for the first time in the spring of* 1938.



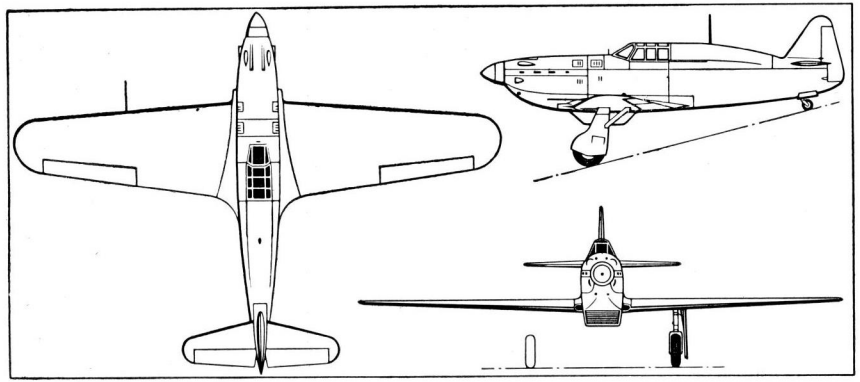


A production Rogozarski IK-3.

Browning machine guns over the engine. The fuselage was a steel-tube structure with plywood and fabric covering, the wings were of wooden construction with plywood skinning, metal-framed, fabric-covered ailerons and dural flaps, and the fully-retractable undercarriage was of Messier design. Initial flight trials were extremely successful, demanding only minor modifications to the undercarriage and engine installation. Five other pilots flight-tested the IK-3 before, on January 19, 1939, the machine was destroyed. The pilot, Captain Pokorni, took-off from Zemun airfield, performed a series of aerobatics and then put the prototype into a terminal velocity dive from which he failed to recover. A subsequent investigation of the accident completely exonerated the aircraft, and the Yugoslav Air Ministry placed an order with the Rogožarski company for an initial batch of twelve IK-3 fighters.

The production IK-3 differed in few respects from the prototype. Additional frames were added to the sliding cockpit canopy, a bullet-proof windscreen was fitted, and the engine was a Czech-built version of the Hispano-Suiza, the Avia H.S. 12Ycrs. The first IK-3s were delivered in the summer of 1940 to the experimental unit, the 52nd Fighter Squadron, whose pilots preferred the indigenous design to both the Bf-109E-3 and the Hurricane I. The IK-3 was appreciably more manoeuvrable than the German fighter and could turn inside the Hurricane with ease. Its controls were exceptionally well co-ordinated and maintenance proved simple despite the fighter's experimental status, a factor of extreme importance in view of the poor equipment of most Yugoslav service airfields. Negotiations were conducted with the Turkish government who were considering the licence manufacture of the IK-3, and plans were made by Rogožarski to accelerate production of the fighter despite the fact that, together with the Zmaj concern, the company was engaged in the licence manufacture of one hundred Hurricanes. Rogožarski's part in the Hurricane programme was forty machines, and with the completion of these the Belgrade factory was to build a further twenty-five IK-3s for the Yugoslav Air Force. In the event, the second batch of IK-3s had only just been started when, on April 6, 1941, German forces invaded Yugoslavia.

In the meantime, the design team had been working on improved versions of the IK-3. It had originally been planned to power later IK-3s with the new 1,100 h.p. Hispano-Suiza 12Y-51 engine, but the German occupation of France had frustrated this plan, and it therefore became necessary to consider a British or German engine. The Air Ministry favoured the DB 601A, and as part of the IK-3 development programme, the Daimler-Benz engine was installed experimentally in a Hurricane airframe in 1940. The conversion was extremely successful, and the experimental aircraft displayed better take-off performance and climb rate than either the standard Hurricane or the Bf 109E-3 and was only slightly slower than the latter. At the same time, a 1,030 h.p. Rolls-Royce Merlin III was installed in one of the IK-3 airframes, but this machine had only just been completed at the time of the



German attack, and as enemy forces neared Belgrade it was destroyed by the factory workers, together with four other IK-3s undergoing overhaul or modification.

One IK-3 had been destroyed when it dived under full power into the Danube, subsequent investigations indicating that the pilot had blacked out, and the remaining six were being operated by the 52nd Squadron which, together with ten Bf 109E-3s of the 32nd Squadron, formed the 6th Fighter Regiment for the aerial defence of Belgrade. Based at Zemun, the IK-3s put up a valiant resistance against the Luftwaffe, scoring a number of "kills" before they were finally destroyed in combat.

It is of interest to note that Rogožarski were working on a further fighter design at the time German forces occupied Belgrade. This, the IK-5, was to be powered by two Hispano-Suiza 12Y engines and was projected in two versions: a single-seat interceptor and a two-seat long-range "destroyer" with exceptionally heavy nose-mounted armament. Wind tunnel tests with models of the IK-5 had been completed, and prototype construction had commenced.

Type: *Single-seat Interceptor Fighter.* **Power Plant:** *One* 920 *h.p. Avia-built Hispano-Suiza* 12 *Ycrs twelve-cylinder Vee liquid-cooled engine.* **Armament:** *One* 20-*mm. Hispano-Suiza HS*-404 *cannon with* 60 *rounds and two* 7.92-*mm. FN-Browning machine guns.* **Performance:** *Maximum speed,* 327 *m.p.h. at* 17,715 *ft.,* 261 *m.p.h. at sea level; normal range* 310 *mls. at* 248 *m.p.h. at* 16,400 *ft.; time to* 16,400 *ft.,* 6.9 *min.; service ceiling,* 26,250 *ft.; normal endurance,* 1.25 *hr.* **Weights:** *Empty,* 4,123 *lb.; normal loaded,* 5,291 *lb.* **Dimensions:** *Span,* 33 *ft.* 9½ *in.; length,* 27 *ft.* 4¾ *in.; height,* 10 *ft.* 8 *in.; wing area,* 178.68 *sq. ft.*

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